NOTICES

OF THE

PROCEEDINGS

AT THE

MEETINGS OF THE MEMBERS

OF THE

Royal Institution of Great Britain,

WITH

ABSTRACTS OF THE DISCOURSES

DELIVERED AT

THE EVENING MEETINGS.

VOL. II.

1854——1858.

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1858.

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1856.

1857.

Royal Institution of Great Britain.

1854.

GENERAL MONTHLY MEETING,

Monday, November 6.

Professor C. Wheatstone, F.R.S. Vice-President, in the Chair.

The following Report was read:—

"*Royal Institution, November* 6, 1854.

"The Managers Report,—That the Fullerian Professorship of Physiology is now vacant; and that, pursuant to the Deed of Endowment, the election of a Professor will take place on Monday, the 2nd of July, 1855, at 4 o'clock, P.M.

"They further Report,—That the next Actonian Prize of £105 will be awarded in the year 1858, to an Essay illustrative of the Wisdom and Beneficence of the Almighty as manifested by the Influence of Solar Radiation.—Competitors for this prize are requested to send their Essays to the Royal Institution, on or before 10 o'clock, P.M., December 31st, 1857, addressed to the Secretary. The adjudication will be made on Monday, April 12th, 1858."

The following Presents were announced, and the thanks of the Members returned for the same:—

From

Her Majesty's Government (by Sir H. De la Beche)—Memoirs of the Geological Survey of the United Kingdom: British Organic Remains, Decades 4, 6, and 7. 4to. 1852–3.

Records of the School of Mines, Vol. I. Parts 2, 3, 4. 8vo. 1853.

Actuaries, Institute of—The Assurance Magazine, Nos. 16, 17. 8vo. 1854.

Agricultural Society of England, Royal—Journal, Vol. XV. Part 1. 8vo. 1854.

Airy, G. B. Esq. Astronomer-Royal—Description of the Transit Circle at the Royal Observatory, Greenwich. 4to. 1854.

American Academy of Arts and Sciences—Proceedings, Vol. II. Nos. 21–29. Vol. III. Nos. 1–13. 8vo. 1849–54.

American Philosophical Society—Proceedings, Nos. 49, 50. 8vo. 1853–4.

Amsterdam, Koninklijke Akademie van Wetenschappen — Verhandelingen, Eerste Deel. 4to. 1854.

Verslagen en Mededeelingen, Eerste Deel; en Tweede Deel, Eerste en Tweede Stuk. 8vo. 1853–4.

Arnold, Thos. J. Esq. (the Author)—Treatise on the Law relating to Municipal Corporations. 12mo. 1851.

Asiatic Society of Bengal—Journal, Nos. 240, 241. 8vo. 1854.
Asiatic Society, Royal—Journal, Vol. XVI. Part 1. 8vo. 1854.
Catalogue of Arabic and Persian MSS. in the Society's Library. By W. H. Morley. 8vo. 1854.
Astronomical Society, Royal—Memoirs, Vol. XXII. 4to. 1854.
Monthly Notices, Vol. XIII. Vol. XIV. Nos. 8, 9. 8vo. 1853-4.
Author—A Catechism explanatory of many of the commonly supposed Difficulties of Christianity. 12mo. 1854.
Basel, Naturforschende Gesellschaft—Berichte über die Verhandlungen, I-VIII. 8vo. 1835-49.
Verhandlungen, Heft I. 8vo. 1854.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal, August to November, 1854. 8vo.
Biber, Rev. G. E. LL.D. M.R.I. (the Author)—Literature, Art, and Science, considered as a means of elevating the Popular Mind. (A Lecture.) 8vo. 1854.
Bombay Geographical Society—Transactions, Vol. XI. 8vo. 1854.
Boosey, Messrs. (the Publishers)—The Musical World for July to Oct. 1854. 4to.
Boston Society of Natural History—Journal, Vol. VI. No. 3. 8vo. 1853.
Proceedings, Nos. 15-24. 8vo. 1852-4.
Botfield, B. Esq. F.R.S. M.R.I. (the Author)—Remarks on the Prefaces to the First Editions of the Classics. 8vo. 1854.
British Architects, Royal Institute of—Proceedings in July, 1854. 4to.
British Association—Report of the Twenty-third Meeting, held at Hull in 1853. 8vo. 1854.
Brown, Andrew, Esq. (the Author)—The Philosophy of Physics, or Process of Creative Developement. 8vo. New York, 1854.
Chemical Society—Quarterly Journal, Vol. VII. Nos. 2, 3. 8vo. 1854.
Commissioners in Lunacy—Eighth Report to the Lord Chancellor. 8vo. 1854.
Cornwall Polytechnic Society, Royal—Twenty-first Annual Report. 8vo. 1853.
Decimal Association—Proceedings, with an Introduction by Professor De Morgan. 8vo. 1854.
East India Company, the Hon.—Gazetteer of the Territories under the Government of the East India Company, and of the Native States on the Continent of India. By E. Thornton. 4 vols. 8vo. 1854.
Editors—The Medical Circular, for July to October, 1854. 8vo.
The Athenæum, for July to October, 1854. 4to.
The Practical Mechanic's Journal, for July to October, 1854. 4to.
The Mechanics' Magazine, for July to October, 1854. 8vo.
The Journal of Gas-Lighting, for July to October, 1854. 4to.
Deutsches Athenäum, July to October, 1854. 4to.
Ethnological Society of London—Address by Sir B. C. Brodie, Bart followed by a Sketch of the recent Progress of Ethnology, by R. Cull. 8vo. 1854.
Faraday, Professor, D.C.L. F.R.S.—Monatsbericht der Königl. Preuss. Akademie, Mai zu August, 1854. 8vo. Berlin.
Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin, 1853. 4to. 1854.
Kaiserliche Akademie der Wissenschaften, Wien:—
Philosophisch-Historische Classe:—Sitzungsberichte, Band XI. Hefte 4, 5; Band XII. Hefte 1-4; und Register zu Band I-X. 8vo. 1854.
Denkschriften. Band V. 4to. 1854.
Archiv für Kunde Œsterreichischer Geschichts Quellen. Band XII. 8vo. 1854.
Notizenblatt. (Beilage zum Archiv.) 1853. Nos. 21-24; 1854. Nos. 1-17.
Fontes Rerum Austriacarum. Zweite Abtheilung. Band I. 1854.
Mathematisch-Naturwissenschaftliche Classe:—Denkschriften. Band VII. 4to. 1854.
Sitzungsberichte. Band XI. Heft 5; Band XII. Hefte 1-4. 8vo. 1853-4.
Tafeln der Polygraphische Apparat. Von A. Auer. 8vo. 1853.

Quetelet, M. Hon.M.R.I. (*the Author*)—Sur le Climat de la Belgique: De l'Hygrométrie. 4to. Bruxelles, 1854.
Sur l'Électricité des Nuages orageux. 8vo.
Phénomènes Périodiques. 16mo. 1852.
Reid, P. Sandeman, Esq.—Letter on the Ventilation of Collieries. By John Buddle. 8vo. 1814.
Royal Society, London—Philosophical Transactions, Vol. CXLIV. Part 1. 4to. 1854.
Proceedings, Vol. VII. No. 4-6. 8vo. 1854.
Sabine, Col. E. R.A. V.P.R.S. (*the Author*)—On some of the Results obtained at the British Colonial Magnetic Observatories. 8vo. 1854.
Smith, Mr. J. Russell (*the Publisher*)—The Retrospective Review. Nos. 7, 8. 1854.
Smithsonian Institution, Washington—Smithsonian Contributions to Knowledge. Vol. VI. 4to. 1854.
Seventh Annual Report. 8vo. 1853.
Annular Eclipse of May 26, 1854. 8vo. 1854.
Società delle Scienze Biologiche in Torino—Memorie, Vol. I. Fascicolo 1. 8vo. 1854.
Society of Arts—Journal for July to October, 1854. 8vo.
Statistical Society—Journal, Vol. XVII. Part 3. 8vo. 1854.
Stephens, Henry, Esq. (*the Author*)—Cholera: an Analysis of its Character. 12mo. 1854.
Taylor, Rev. W. F.R.S. M.R.I.—Magazine for the Blind, August to November, 1854. 4to.
Von der Schlaflosigkeit, deren Ursachen und Heilart. Von Dr. A. F. Fischer. 16mo. Nürnberg, 1831.
Van Diemen's Land, Royal Society of—Papers and Proceedings. Vol. II. Part 2. 8vo. 1854.
Vereins zur Beförderung des Gewerbfleisses in Preussen—Verhandlungen, Mai zu August, 1854. 4to. Berlin.
Warburton, Henry, Esq. M.A. F.R.S. M.R.I. (*the Author*)—On Self-repeating Series. 4to. 1854.
Washington National Observatory—Astronomical Observations made during 1847. 4to. 1853.
Webster, John, M.D. F.R.S. M.R.I.—General Reports of the Royal Hospitals of Bridewell and Bethlem, and of the House of Occupations. 8vo. 1853.
Williams, C. W. Esq. (*the Author*)—The Combustion of Coal and the Prevention of Smoke chemically and practically considered. 8vo. 1854.
Yates, James, Esq. M.A. F.R.S. M.R.I.—On the French System of Measures, Weights, and Coins; by James Yates, Esq. F.R.S. With an Abstract of the Discussion on the Paper, at the Society of Arts. 8vo. 1854.
Comparative Statement of Different Plans of Decimal Accounts and Coinage. By Th. W. Rathbone. 8vo. 1854.
Decimal Coinage—A Practical Analysis with Tables. By James Laurie. 8vo. 1854.
Yorkshire Geological and Polytechnic Society—Proceedings, 1853. 8vo. 1854.

Jopling, R. F. Esq. (the Editor)—The Statist, No. 1. 8vo. 1854.
Medical and Chirurgical Society, Royal—Medico-Chirurgical Transactions, Vol. XXXVII. 8vo. 1854.
Novello, Mr. (the Publisher)—The Musical Times for November and December, 1854.
Photographic Society—Journal, No. 24. 8vo. 1854.
Pollock, Frederick, Esq. M.A. M.R.I.—Euleri Opuscula. 3 vols. 4to. Berolini, 1746–51.
Pollock, Thomas, Esq. (the Author)—On the peculiar State of the Atmosphere during the late Epidemic Cholera and Diarrhœa. 8vo. 1854.
Price, Rev. Bartholomew, M.A. F.R.S. (the Author)—A Treatise on the Infinitesimal Calculus. Vol. II. 8vo. 1854.
Rathbone, Th. W. Esq. (the Author)—Preface to the Comparative Statement on Decimal Accounts and Coinage. 8vo. 1854.
Society of Arts—Journal for November, 1854. 8vo.
Statistical Society—Journal, Vol. XVII. Part 4. 8vo. 1854.
Taylor, Alfred S. M.D. F.R.S. M.R.I. (the Author)—Medical Jurisprudence. 5th Edition. 16mo. 1854.
Taylor, Rev. W. F.R.S. M.R.I.—The Magazine for the Blind, December, 1854.
Wilhelm Von Humboldt—Lichtstrahlen aus seinen Briefen: mit einer Biographie Humboldts, von Elisa Maier. 16mo. Leipzig, 1852.
Ueber das Sehen und die Farben, eine Abhandlung von A. Schopenhauer. 8vo. Leipzig, 1816.
Vereins zur Beförderung des Gewerbfleisses in Preussen—Verhandlungen, September und October, 1854. 4to.

1855.

WEEKLY EVENING MEETING,

Friday, January 19.

William Robert Grove, Esq. Q.C. F.R.S. Vice-President, in the Chair.

Professor Faraday, D.C.L. F.R.S.

On some points of Magnetic Philosophy.

The magnetic and electric forms of power, being dual in their character, and also able to act at a distance, will probably aid greatly in the development of the nature of physical force generally: and if (as I believe) the dualities are essential to the forces, are always equal and equivalent to each other, and are so mutually dependent, that one cannot appear, or even exist, without the other, the proof of the truth of such conditions would lead to many consequences of the highest importance to the philosophy of force generally. A few brief experiments with the electric power quickly place the dual

it to the prominent corners; bismuth moved up into it; and a third like pole on the opposite side made the place of weak force still weaker and larger; another pole or two made it very weak; six poles brought it to the condition above described. Even four poles, put with their longer edges together, produced a lengthened chamber with two entrances; and a little needle being carried in at either entrance passed rapidly through spaces of weaker and weaker force, and found a part in the middle where magnetic action was not sensible.

Other very interesting results were obtained by making chambers in the polar extremities of electro-magnets. A cylinder magnet, whose core was 1·5 inches in diameter, had a concentric cylindrical chamber formed in the end, 0·7 in diameter, and 1·3 inches deep. When iron filings were brought near this excited pole, they clung around the outside, but none entered the cavity, except a very few near the outer edge. When they were purposely placed inside on a card they were quite indifferent to the excited pole, except that those near the mouth of the chamber moved out and were attracted to the outer edges. A piece of soft iron at the end of a copper wire was strongly attracted by the outer parts of the pole, but unaffected within. When the chamber was filled with iron filings and inverted, the magnet being excited, all those from the bottom and interior of the chamber fell out; many, however, being caught up by the outer parts of the pole. If pieces of iron, successively increasing from the size of a filing to a nail, a spike, and so on to a long bar, were brought into contact with the same point at the bottom of the inverted chamber, though the filing could not be held by attraction, nor the smaller pieces of iron, yet as soon as those were employed which reached to the level of the chamber mouth, or beyond it, attraction manifested itself; and with the larger pieces it rose so high that a bar of some pounds weight could be held against the very spot that was not sufficient to retain an iron filing.

These and many other results prove experimentally, that the magnetic dualities cannot appear alone; and that when they are developed they are in equal proportions and essentially connected. For if not essentially connected, how could a magnet exist alone? Its power, evident when other magnets, or iron, or bismuth is near it, must, upon their removal, then take up some *other form*, or exist *without action*: the first has never been shown or even suspected; the second is an impossibility, being inconsistent with the conservation of force. But if the dualities of a single magnet are thrown upon each other, and so become mutually related, is that in right lines through the magnet, or in curved lines through the space around? That it is not in right lines through the magnet (it being a straight bar or sphere) is shown by this, that the proper means as a helix round the magnet, shows that the *internal* disposition of the *force* (coercitive or other) is not affected when the magnet is exert-

the magnetic condition assigned by some to bismuth (*i.e.* with reversed polarities), it then differed from bismuth, producing the contrary deflection. [For a further account of these considerations and investigations, a paper may be referred to, which will appear in the February number of the Philosophical Magazine.]

It is, probably, of great importance that our thoughts should be stirred up at this time to a reconsideration of the general nature of physical force, and especially to those forms of it which are concerned in actions at a distance. These are, by the dual powers, connected very intimately with those which occur at insensible distances; and it is to be expected that the progress which physical science has made in latter times will enable us to approach this deep and difficult subject with far more advantage than any possessed by philosophers at former periods. At present we are accustomed to admit action at sensible distances, as of one magnet upon another, or of the sun upon the earth, as if such admission were itself a perfect answer to any enquiry into the nature of the physical means which cause distant bodies to affect each other; and the man who hesitates to admit the sufficiency of the answer, or of the assumption on which it rests, and asks for a more satisfactory account, runs some risk of appearing ridiculous or ignorant before the world of science. Yet Newton, who did more than any other man in demonstrating the law of action of distant bodies, including amongst such the sun and Saturn, which are 900 millions of miles apart, did not leave the subject without recording his well-considered judgment, that the mere attraction of distant portions of matter was not a sufficient or satisfactory thought for a philosopher. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is, he says, to him a great absurdity. Gravity must be caused by an agent, acting constantly according to certain laws; but whether this agent be material or immaterial he leaves to the consideration of his readers. This is the onward looking thought of one, who by his knowledge and like quality of mind, saw in the diamond an unctuous substance coagulated, when as yet it was known but as a transparent stone, and foretold the presence of a combustible substance in water a century before water was decomposed or hydrogen discovered: and I cannot help believing that the time is near at hand, when his thought regarding gravity will produce fruit:—and, with that impression, I shall venture a few considerations upon what appears to me the insufficiency of the usually accepted notions of gravity, and of those forces generally, which are supposed to act at a distance, having respect to the modern and philosophic view of the conservation and indestructibility of force.

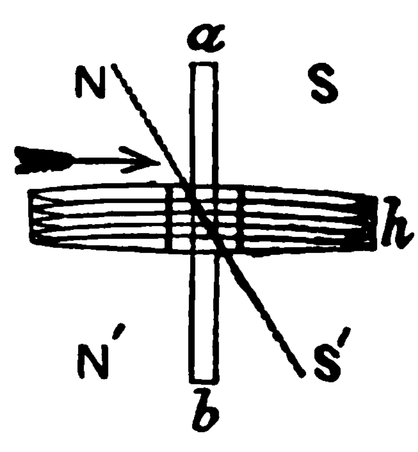
The notion of the gravitating force is, with those who admit

Such, I think, must be the character of the conclusion, if it be supposed that the attraction of the sun upon the earth arises *because* of the presence of the earth, and the attraction of the earth upon the sun, because of the presence of the sun: there remains the case of the power, or the efficient source of the power, having pre-existed in the sun (or the earth) *before* the earth (or the sun) was in presence. In the latter view it appears to me that, consistently with the conservation of force, one of three sub-cases must occur: either the gravitating force of the sun, when directed upon the earth, must be removed in an equivalent degree from some other bodies, and when taken off from the earth (by the disappearance of the latter) be disposed of on some other bodies;—or else it must take up some *new* form of power when it ceases to be gravitation, and consume some other form of power when it is developed as gravitation;—or else it must be *always* existing around the sun through infinite space. The first sub-case is not imagined by the usual hypothesis of gravitation, and will hardly be supposed probable: for, if it were true, it is scarcely possible that the effects should not have been observed by astronomers, when considering the motions of the planets in different positions with respect to each other and the sun. Moreover, gravitation is not assumed to be a dual power, and in them only as yet have such removals been observed by experiment or conceived by the mind. The second sub-case, or that of a new or another form of power, is also one which has never been imagined by others, in association with the theory of gravity. I made some endeavours, experimentally, to connect gravity with electricity, having this very object in view (*Phil. Trans.* 1851, p. 1); but the results were entirely negative. The view, if held for a moment, would imply that not merely the sun, but all matter, whatever its state, would have extra powers set up in it, if removed in any degree from gravitation; that the particles of a comet at its perihelion would have changed in character, by the conversion of some portion of their molecular force into the increased amount of gravitating force which they would then exert; and that at its aphelion, this extra gravitating force would have been converted back into some other kind of molecular force, having either the former or a new character: the conversion either way being to a perfectly equivalent degree. One could not even conceive of the diffusion of a cloud of dust, or its concentration into a stone, without supposing something of the same kind to occur; and I suppose that nobody will accept the idea as possible. The third sub-case remains, namely, that the power is always existing around the sun and through infinite space, whether secondary bodies be there to be acted upon by gravitation or not: and not only around the sun, but around every particle of matter which has existence. This case of a constant necessary condition to action in space, when as respects the sun the earth is *not* in place, and of a certain gravitating action as the result of that pre-

to all the forces capable of acting upon them magnetically; first, to the magnet alone; secondly, to the electric current alone; and, thirdly, to the magnet and current combined. Attention to structure was here found very necessary, and the neglect of it appears to have introduced much error into this portion of science. Powdered bismuth, without the admixture of any foreign ingredient, was placed in a strong metallic mould, and submitted to the action of a hydraulic press; perfectly compact metallic masses were thus procured, which, suspended in the magnetic field with the line of compression horizontal, behaved exactly like magnetic bodies, setting their longest dimensions from pole to pole. This identity of deportment with an ordinary magnetic substance was also exhibited in the case of the electric current, and of the current and the magnet combined. In like manner, by the compression of a magnetic powder magnetic bars were produced, which, between the two poles of a magnet, set exactly like ordinary dia-magnetic ones; this identity of deportment is preserved when the bars are submitted to the action of the current, and of the current and magnet combined. Calling those bars which show the ordinary magnetic and dia-magnetic action *normal bars*, and calling the compressed bars *abnormal ones*, the law follows, that an abnormal bar of one class of bodies exhibits precisely the same deportment, in all cases, as the normal bar of the other class; but when we compare normal bars of both classes together, or abnormal bars of both classes, then the antithesis of action is perfect. The experiments prove that, if that which Gauss calls the *ideal distribution* of magnetism in magnetic bars be inverted, we have a distribution which will produce all the phenomena of dia-magnetic ones.

The important question of dia-magnetic polarity was submitted to further and stricter examination. A flat helix, whose length was an inch, internal diameter an inch, and external diameter seven inches, was attached firmly to a table, with its coils vertical. A suspension was arranged by means of which a bar of bismuth, five inches long, and 0·4 of an inch in diameter, was permitted to swing freely, while surrounded by the helix. With this arrangement, the following experiments were, or might be made:—1. A voltaic current from twenty of Grove's cells was sent through the helix *h*, the direction of the current *in the upper half* of the helix being that denoted by the arrow (Fig. 1). The north pole of a magnet being placed at N, the end *a* of the suspended bar of bismuth, *a b*, was *attracted* towards the pole N. 2. The south pole of a second magnet being placed at S, and the current being sent through the helix in the same direction as before, the bar left its central position and approached N with greater force than in the

Fig 1.



of the force acting upon every particle of the mass of bismuth tends to turn the lever round its axis of suspension, in the direction of the curved arrow. On exciting the magnetism of P, however, a precisely contrary motion is observed—*the lever approaches the pole.* This result, which, as far as the lecturer could see, was perfectly inexplicable on the assumption that the dia-magnetic force was purely repulsive, is explained in a simple and beautiful manner on the hypothesis of dia-magnetic polarity. According to this, the end *b* of the bar of bismuth is repelled by P, and the end *a* is attracted: but the force acting upon *a* is applied at a greater distance from the axis of suspension than that acting upon *b*; and as it has been arranged* that the absolute intensities of the forces acting upon the two ends differ very slightly from each other, the mechanical advantage possessed by *a* gives to it the greatest moment of rotation, and the bar is attracted instead of repelled. Let a magnetic needle *n s* (Fig. 3,) be attached like the bar *a b* (Fig. 2) to a lever, and submitted to the earth's magnetism. Let the north pole of the earth be towards N; the action of the pole upon *n* is attractive, upon *s* repulsive, the absolute intensities of these forces are the same, inasmuch as the length of the needle is a vanishing quantity in comparison with its distance from the pole N: hence the mechanical advantage possessed by the force acting upon *s*, on account of its greater distance from the axis of rotation, causes the lever to recede from N, and we obtain a result perfectly analogous to that obtained with the bar of bismuth (Fig. 2).*

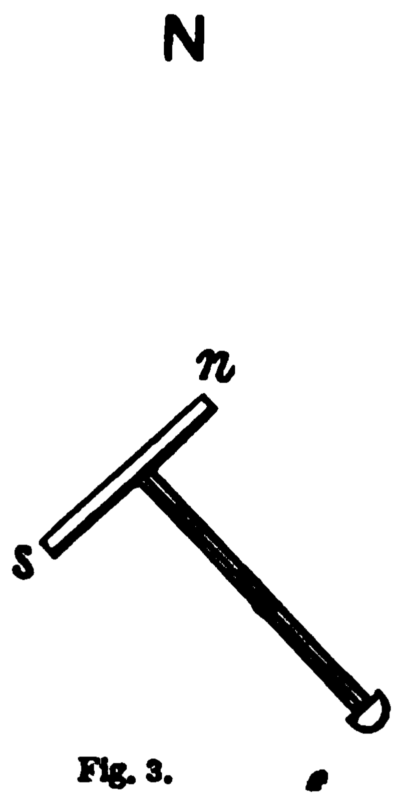


Fig. 3.

[J. T.]

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* A paper submitted to the Royal Society last November, and a portion of which formed the subject of the Bakerian Lecture for the present year, contains a more comprehensive discussion of this subject. In it are explanations, which it is hoped will be deemed satisfactory, of the difficulties adduced by M. Matteucci, in his instructive *Cours Special*, recently published.

brain-expanded cranium. The hind limbs in man are longer in proportion to the trunk than in any other known mammalian animal. The kangaroo might seem to be an exception, but if the hind limbs of the kangaroo are measured in relation to the trunk, they are shorter than in the human subject. In no animal is the femur so long in proportion to the leg as in man. In none does the tibia expand so much at its upper end. Here it presents two broad shallow cavities for the reception of the condyles of the femur. Of these condyles in man only is the innermost longer than the outermost; so that the shaft of the bone inclines a little outwards to its upper end, and joins a "neck" longer than in other animals, and set on at a very open angle. The weight of the body, received by the round heads of the thigh bones, is thus transferred to a broader base, and its support in the upright posture facilitated. There is also the collateral advantage of giving more space to those powerful adductor muscles that assist in fixing the pelvis and trunk upon the hind limbs. With regard to the form of the pelvis, you could not fully appreciate its peculiar modifications unless you saw it, as here displayed, in contradistinction to the form of the pelvis in the highest organised quadrumana. The short and broad ilium bends forwards, the better to receive and sustain the abdominal viscera, and is expanded behind to give adequate attachment to the powerful glutei muscles, which are developed to a maximum in the human species, in order to give a firm hold of the trunk upon the limbs, and a corresponding power of moving the limbs upon the trunk. The tuberosities of the ischium are rounded, not angular, and not inclined outwards, as in the ape tribe. The symphysis pubis is shorter than in the apes. The tail is reduced to three or four stunted vertebræ, anchylosed to form the bone called "os coccygis." The true vertebræ, as they are called in human anatomy, correspond in number with those of the chimpanzee and the orang, and in their divisions with the latter species, there being twelve thoracic, five lumbar, and seven cervical. This movable part of the column is distinguished by a beautiful series of sigmoid curves, convex forwards in the loins, concave in the back, and again slightly convex forwards in the neck. The cervical vertebræ, instead of having long spinous processes, have short processes, usually more or less bifurcated. The bodies of the true vertebræ increase in size from the upper dorsal to the last lumbar, which rests upon the base of the broad wedge-shaped sacrum, fixed obliquely between the sacro-iliac articulations. All these curves of the vertebral column, and the interposed elastic cushions, have relation to the libration of the head and upper limbs, and the diffusion and the prevention of the ill effects from shocks in many modes of locomotion which man, thus organised for an erect position, is capable of performing. The arms of man are brought into more symmetrical proportions with the lower limbs; and their bony framework shows all the perfections that have been superinduced upon it in the mammalian

compare with the most perfect spring water, which reservoir, or head of distribution, would be 120 feet perpendicular above the datum line of the Ordnance Survey, made at the suggestion of the Board of Health.* The Ordnance map of London, the fruit of that survey, on the scale of 12 inches to the mile, with the elevation of every part of the metropolis stated upon it, was exhibited, which embraced also the reservoir; and, by means of a line of uniform level traced upon the map, it was made apparent how very large a portion of London could be supplied by gravitation, at high-service level, over and above the whole of Westminster, Belgravia, Knightsbridge, Brompton, Chelsea, Fulham, and Kensington. Mr. Dickinson, having had a great deal of experience in works of this nature, was satisfied that the cost of delivering this quantity of water at Kilburn, purified and filtered, (presuming money to be obtainable at 4 per cent. per annum,) would not (according to Mr. Thom's mode of estimate) exceed three farthings per thousand gallons, including the very heavy item of compensation to mill-owners; and that the whole cost of distribution would not exceed threepence per thousand gallons, which, as proved in the evidence of Mr. Hawksley, was the rate of charge for the water supply at Nottingham.

Some of the water taken out of the river Colne, at Harefield, was produced at the meeting and much approved. With reference to the liability of the Colne being rendered turbid at the time of floods, (for at other times it is perfectly clear,) he quoted the following evidence of Mr. Hawksley on the subject of running water purifying itself,—"I can give a very extraordinary instance of "that, as occurring at Nottingham. At Nottingham the supply is "taken from the river Trent. Upon the tributaries of the river "Trent are situated the towns of Leicester, Loughborough, Derby, "Belton, and the whole of the Potteries. The water leaves those "towns frequently in an exceedingly black noisome state, but the "water of the river Trent is, nevertheless, exceedingly beautiful "and pellucid; in fact, at Trent Bridge, near Nottingham, it is as "clear as crystal; organic matter is not discoverable in it, except "in the degree in which it is discoverable in all river water."

The speaker concluded by stating that he had taken particular notice of the amount of water expended in his own house and stables, (in Upper Brook Street,) and it led him to the conviction that the whole of the large and populous district, before referred to, southward of, and including Piccadilly, might be supplied by this application of the gravitation system at one-fourth the scale of the present rate of charge; but with the proviso, that water for the streets and for public purposes, should be paid for out of the parish rates as at present. [J. D.]

* This quantity is almost exactly double that of the New River, the total supply of which is stated by Mr. Mylne, the engineer of that Company, in his evidence before the Parliamentary Committee of Inquiry, respecting the water-supply of London, Qu: 3073, to be 11,872,000 gallons per diem.

GENERAL MONTHLY MEETING,

Monday, April 2.

Aaron Asher Goldsmid, Esq.
in the Chair.

Eustace Anderson, Esq.
Andrew Whyte Barclay, M.D. and
Thomas Parry Woodcock, Esq.

were duly *elected* Members of the Royal Institution.

John Baily, Esq. Q.C.	John Dickinson, Esq.
Charles Beevor, Esq.	Rev. George Delgarno Hill.
Henry Bradbury, Esq.	Henry M. Noad, Esq. Ph.D. F.R.S.

were *admitted* Members of the Royal Institution.

A Special Vote of Thanks was returned to His Grace the Duke of Northumberland, the President, for his Present of a magnificently bound copy of Rosellini's "Monumenti dell' Egitto e della Nubia," in nine volumes 8vo, with an Atlas of Plates in three volumes folio.

The following Presents were announced, and the thanks of the Members returned for the same.

From

Her Majesty's Government (through Sir H. De la Beche)—Catalogue of Specimens (at the Museum of Practical Geology) illustrative of the Composition and Manufacture of British Pottery and Porcelain. By Sir H. De la Beche and T. Reeks. 8vo. 1855.

Actuaries, Institute of—The Assurance Magazine. No. XIX. 8vo. 1855.

Anderson, W. J. Esq. M.R.I. (the Author)—Continued Fever in Children. 12mo. 1854.

Astronomical Society, Royal—Monthly Notices. Vol. XIV. and Vol. XV. No. 4. 8vo. 1855.
Memoirs. Vol. XXIII. 4to. 1854.

Bayerische Akademie der Wissenschaften, die Königliche—Abhandlungen, Band VII. 2te Abtheilung. 4to. Munich, 1854.
Bulletin für 1853. 4to.
Magnetische Ortsbestimmungen in Bayern. Von Dr. J. Lamont. Theil I. 8vo. 1854.
Annalen der Königlichen Sternwarte bei München. Band VI. Von Dr. J. Lamont. 8vo. 1854.

ANNUAL MEETING,

Tuesday, May 1.

THE DUKE OF NORTHUMBERLAND, K.G. F.R.S. President, in the Chair.

The Annual Report of the Committee of Visitors was read, and adopted.—It states that the Contributions from Members and Annual Subscribers in 1854 were very satisfactory, as well as the Receipts for attendance at the courses of Lectures. The General Income exceeded the Expenditure of the year by the sum of £795. 2*s.* 4*d.*; and the Managers were enabled, in addition to the annual investment of the Accumulating Funds, amounting to £184. 10*s.* 1*d.*, to lay out £500 in the purchase of £3 per cent. Consols, and to buy an Exchequer Bill for £100.

A List of Books Presented accompanies the Report, amounting in number to about 175 volumes, and making a total, with those purchased by the Managers and Patrons, of nearly 900 volumes (including Periodicals) added to the Library in the year.

Thanks were voted to the President, Treasurer, and Secretary, to the Committees of Managers and Visitors, and to Professor Faraday, for their services to the Institution during the past year.

The following Gentlemen were unanimously elected as Officers for the ensuing year:—

PRESIDENT—The Duke of Northumberland, K.G. F.R.S.

TREASURER—William Pole, Esq. M.A. F.R.S.

SECRETARY—Rev. John Barlow, M.A. F.R.S.

MANAGERS.

William H. Blaauw, Esq. M.A. F.S.A.
Sir Benjamin Collins Brodie, Bart. D.C.L. F.R.S.
John Bate Cardale, Esq.
Thomas Davidson, Esq.
George Dodd, Esq. F.S.A.
Sir Charles Fellows.
Aaron Asher Goldsmid, Esq.
Sir Henry Holland, Bart. M.D. F.R.S.
Henry Bence Jones, M.D. F.R.S.
George Macilwain, Esq.
Right Hon. Baron Parke, M.A.
John Percy, M.D. F.R.S.
Lieut.-Gen. Sir George Pollock, G.C.B.
Alfred S. Taylor, M.D. F.R.S.
Charles Wheatstone, Esq. F.R.S.

that the Government had lately organized the means of examining the merits of every suggested improvement, and that the appointed parties were now actively engaged in the investigation. At present there appear two improvements in the art of war, in which chemical science may be of service: the one in making shells, which shall burst upon striking—about which there is no chemical difficulty; the other in charging shells with substances that will give forth quantities of poisonous gas; a subject which has lately attracted much attention. It is to be hoped, that not only mechanical, but also chemical science, will soon furnish us with improvements on the present means of carrying on the war in which we are now engaged.

[J. H. G.]

GENERAL MONTHLY MEETING,

Monday, May 7.

THE DUKE OF NORTHUMBERLAND, K.G. F.R.S. President, in the Chair.

George Ade, Esq., and
William Stuart, Esq.

were duly *elected* Members of the Royal Institution.

Andrew Whyte Barclay, M.D.

was *admitted* a Member of the Royal Institution.

The following Professors were unanimously re-elected:—

WILLIAM THOMAS BRANDE, Esq. D.C.L. F.R.S. L. & E., as Honorary Professor of Chemistry in the Royal Institution.

JOHN TYNDALL, Esq. Ph.D. F.R.S., as Professor of Natural Philosophy in the Royal Institution.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM

Allies, Thomas W. Esq. M.A. M.R.I. (the Author)—St. Peter, his Name, and his Office, as set forth in the Holy Scriptures. 8vo. 1852.

Journal in France, in 1845 and 1848; with Letters from Italy, in 1847. 12mo. 1849.

The Royal Supremacy, viewed in reference to the two Spiritual Powers of Order and Jurisdiction. 8vo. 1850.

Weale, John, Esq. (the Publisher)—Educational Series. 12mo.:—
Chronology of History, Art, and Literature. Vol. I. 1854.
Dictionary of the English Language. By Hyde Clarke. 1855.
Grammar of the Greek Language. By H. C. Hamilton. 1854.
Lexicon of the Greek Language. By H. R. Hamilton. Part II. 1853.
English-Greek Lexicon. By H. R. Hamilton. Part I. 1855.
Grammar of the Latin Tongue. By T. Goodwin. 1854.
Latin-English Dictionary. By T. Goodwin. 1855.
French-English, and English-French Dictionary. By A. Elwes. 2 Parts. 1854–5.
Italian-English-French Dictionary. By A. Elwes. Part I. 1855.
Spanish-English, and English-Spanish Dictionary. By A. Elwes. 1854.
Hebrew and English Dictionary and Grammar. By M. H. Bresslau. 1855.
Classical Series. 12mo. (Edited by H. Young.)
Greek Delectus. 1854.
Xenophon's Anabasis. 2 vols. 1854–5.
Select Dialogues of Lucian. 1855.
Latin Delectus. 1854.
Cæsar's Commentaries. 1854.
Cornelius Nepos. 1855.
Virgil. Part I. 1855.

WEEKLY EVENING MEETING,

Friday, May 11.

Sir Charles Fellows, Vice-President, in the Chair.

Henry Bradbury, Esq. M.R.I.

On Nature-Printing.

The Art of Nature-Printing is a method of producing impressions of plants and other natural objects, in a manner so truthful that only a close inspection reveals the fact of their being copies. So distinctly sensible to the touch are the impressions, that it is difficult to persuade those unacquainted with the manipulation, that they are the production of the printing-press. The process, in its application to the reproduction of botanical subjects, represents the size, form, and colour of the plant, and all its most minute details, even to the smallest fibre of the roots.

The distinguishing feature of the process, compared with other modes of producing engraved surfaces for printing purposes, consists, firstly, in impressing natural objects—such as plants, mosses, seaweeds, feathers, and embroideries—into plates of metal, causing as it were the objects to engrave themselves by pressure; and secondly, in being able to take such casts or copies of the impressed plates as can be printed from at the ordinary copperplate-press.

NATURE PRINTING

Haidinger, for having promptly suggested the impression of a plant into a plate of metal at the very time the *modus operandi* had been provided;
Abate, for its application to the representation of different sorts of ornamental woods on woven fabrics, paper, and plain wood;
Worring, of the Imperial Printing-Office, Vienna,* for his practical services in carrying out the plans of Leydolt and Haidinger.

Nature-Printing may be considered as still in its infancy; but the results, already obtained in its application, encourage us to expect from continued efforts such further improvements as will place it not least among the Printing Arts.

[H. B.]

[A great number of specimens of Nature-Printing, in its various applications, were exhibited; and the different processes referred to by the speaker, were exemplified in the presence of the audience, during and after the discourse, by workmen and apparatus from the establishment of Messrs. Bradbury and Evans.]

WEEKLY EVENING MEETING,

Friday, May 18.

Rev. John Barlow, M.A. F.R.S. Vice-President and Secretary, in the Chair.

James Philip Lacaita, Esq. LL.D.

On Dante and the "Divina Commedia."

The speaker, after a few preliminary remarks, proceeded to state, that he should not attempt to give an account of the life of Dante, which was so connected with the chief events of his time, that it was impossible to sketch it with any degree of interest, without entering into many details of the mediæval history of Italy. Carlo Troya, and Count Cesare Balbo, two of the most profound Italian

* It is gratifying to know that the services of this gentleman were recognised by his Sovereign, who munificently rewarded him with a gift, and likewise the Order of Merit.

NATURE PRINTING

induction, where water is the conductor, whilst it is known to be essential to the many, only because, when water is the electrolyte employed, electrolytic conduction is essential to every case of electrolytic action.

[M. F.]

WEEKLY EVENING MEETING,

Friday, June 1.

The Duke of Northumberland, K.G. F.R.S. President, in the Chair.

Professor Tyndall, F.R.S.

On the Currents of the Leyden Battery.

In our conceptions and reasonings regarding the forces of nature we perpetually make use of symbols, which, when they possess a high representative value, we dignify with the name of theories. We observe, for example, heat propagating itself through a bar of metal, and help ourselves to a conception of the process by comparing it with water percolating through sand, or travelling by capillary attraction through a lump of sugar. In some such way we arrive at what is called the material theory of heat. The thing seen is thus applied to the interpretation of the thing unseen, and the longing of the human mind to rest upon a satisfactory reason, is in some measure satisfied. So also as regards the subject of the present evening's discourse; we are not content with the mere facts of electricity; we wish to look behind the fact, and prompted by certain analogies we ascribe electrical phenomena to the action of a peculiar fluid. Such conceptions have their advantages and their disadvantages: they afford peaceful lodging to the intellect for a time, but they also circumscribe it; and by and by, when the mind has grown too large for its mansion, it often finds a difficulty in breaking down the walls of what has become its prison instead of its home. Thus, at the present day, the man who would cross the bounds which at present limit our knowledge of electricity and magnetism finds it a work of extreme difficulty to regard facts in their simplicity, or to rid them of those hypothetical adornments with which common consent has long invested them.

But though such is the experience of the earnest student of Natural Philosophy at the present—though he may be compelled to refuse his assent to the prevalent theoretic notions, he may never-

We have every reason to suppose that the secondary current thus developed is of the same nature as the primary which produced it; and hence we may infer, that if we conduct the secondary away and carry it through a second spiral, it, in its turn, will act the part of a primary, and evoke a *tertiary* current in a spiral brought near it. This was illustrated by experiment. First, two spirals were placed opposite to each other, through one of which the current of the battery was to be sent; the other was that in which the secondary current was to be aroused. The ends of the latter were connected by wires with a third spiral placed at a distance, so that when the secondary current was excited it passes through the third spiral. Underneath the latter, and separated from it by a sheet of varnished glass, was a fourth spiral, whose two ends were connected with the universal discharger, between the knobs of which a quantity of gun-cotton was placed. When the battery was discharged through the first spiral, a secondary current was aroused in the second spiral, which completed its circuit by passing through the third spiral: here the secondary acted upon the spiral underneath, developed a tertiary current which was sufficiently strong to pass between the knobs, and to ignite the gun-cotton in its passage. It was shown that we might proceed in this way and cause the tertiary to excite a current of the fourth order, the latter a current of the fifth order, and so on; these children, grandchildren, and great grandchildren of the primary being capable of producing all the effects of their wonderful progenitor.

The phenomena of the *extra current*, which exists for an instant contemporaneously with the ordinary current in a common voltaic spiral, were next exhibited; and the question whether a spiral through which a Leyden battery was discharged exhibited any similar phenomena was submitted to examination. It was proved, that the electric discharge depended upon the *shape* of the circuit through which it passed: when two portions of such a circuit are brought near each other, so that the positive electricity passes in the same direction though both of them, the effect is that the discharge is *weaker* than if sent through a straight wire: if, on the contrary, the current flow through both portions in opposite directions the discharge is *stronger* than if it had passed through a straight wire. A flat spiral was taken, containing 75 feet of copper wire; one end of the spiral was connected with a knob of the universal discharger, and the other knob was connected with the earth: between the knobs of the discharger about four inches of platinum wire were stretched; on connecting the other end of the spiral with the battery a discharge passed through it of such a strength that it was quite unable to raise the platinum wire to the faintest glow. The same length of copper wire was then bent to and fro in a zigzag manner, so that on every two adjacent legs of the zigzag the current from the battery flowed in opposite directions. When these 75 feet of wire were interposed between the battery and the platinum wire, a discharge

GENERAL MONTHLY MEETING,

Monday, June 4.

THE DUKE OF NORTHUMBERLAND, K.G. F.R.S. President, in the Chair.

J. S. Coleman, Esq.
Wm. De Lannoy, Esq.
George H. Ingall, Esq.
Col. William Kirkman Loyd.
R. Bentley Todd, M.D. F.R.S.

were duly *elected* Members of the Royal Institution.

George Ade, Esq.

was *admitted* a Member of the Royal Institution.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM

Administration of the Mines of Russia—Compte Rendu Annuel, 1853. Par A. T. Kupffer. 4to. St. Petersburg. 1854.
Asiatic Society of Bengal—Journal, No. 246. 8vo. 1855.
Astronomical Society, Royal—Monthly Notices. Vol. XV. No. 6. 8vo. 1855.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for May, 1855. 8vo.
Blashfield, J. M. Esq. M.R.I. (the Author)—History and Manufacture of Terra-Cotta, Ancient and Modern. 8vo. 1855.
Boosey, Messrs. (the Publishers)—The Musical World for May, 1855. 4to.
British Architects, Royal Institute of—Proceedings in May, 1855. 4to.
Civil Engineers, Institution of—Proceedings in May, 1855. 8vo.
Dilke, C. Wentworth, Esq. (the Author)—Catalogue of a Collection of Works on, or having reference to, the Exhibition of 1851, in the possession of C. W. Dilke. 8vo. 1855.
Editors—The Medical Circular for May, 1855. 8vo.
The Practical Mechanic's Journal for May, 1855. 4to.
The Journal of Gas-Lighting for May, 1855. 4to.
The Mechanics' Magazine for May, 1855. 8vo.
Deutsches Athenäum for May, 1855. 4to.
The Athenæum for May, 1855. 4to.
Faraday, Professor, D.C.L. F.R.S.—Monatsbericht der Königl. Preuss. Akademie, für April, 1855. 8vo. Berlin.
Whitelocke, B.—Journal of the Swedish Ambassy in 1653-4, from the Commonwealth of England, Scotland, and Ireland, written by the Ambassador, the Lord Commissioner Whitelocke. 2 vols. 4to. 1762.
Shermann, A. J.—Historia Collegii Jesu Cantabrigiensis, edidit et notis instruxit J. O. Halliwell. 8vo. 1840.

Faraday, Professor, D.C.L. F.R.S.—Pictet, M. A.—Essais sur le Feu. 8vo. Genève, 1790.

Pött, J. H.—Dissertations Chymiques, recueillies et traduites, par J. F. Demachy. 4 vols. 12mo. Paris, 1759.

Recueil de Mémoires et d'Observations sur la Formation et sur la Fabrication du sal pêtre. Par les Commissaires nommés par l'Académie pour le jugement du prix du sal pêtre. 8vo. Paris, 1776.

Ségur, Octave.—Lettres Elémentaires sur la Chimie. 2 vols. 18mo. 1803.

Stahl, G. E.—Traité des Sels. 18mo. Paris, 1783.

Otto Tachenius.—Hippocrates Chymicus. Translated by J. W. 4to. 1677.

Brück, R.—Electricité ou Magnétisme du Globe Terrestre. 8vo. Bruxelles, 1851.

Bostock, J.—An Account of the History and Present State of Galvanism. 8vo. 1818.

Carpue, J. C.—An Introduction to Electricity and Galvanism. 8vo. 1803.

Nollet, J. A.—Lettres sur l'Electricité. Nouvelle Ed. 2 vols. 12mo. Paris, 1764.

Guglielmini, D.—Della Natura de Fiumi. 4to. Bologna, 1697.

Smyth, Capt W. H.—Nautical Observations on the Port and Maritime Vicinity of Cardiff, and on the Bute Docks. 8vo. 1840.

Theophrastus.—History of Stones, by J. Hill: with two Letters. 8vo. 1746.

Martin, W.—Outlines of an attempt to establish a knowledge of Extraneous Fossils. 8vo. 1809.

Burnet, T.—The Theory of the Earth. 3rd Ed. fol. 1697.

Smith, J. Pye—On the Relation between the Holy Scriptures and some Parts of Geological Science. 8vo. 1839.

Schlagintweit, H. und A.—Untersuchungen über die Physikalische Geographie der Alpen. 4to. 1850.

Knight, W.—Facts and Observations towards forming a New Theory of the Earth. 8vo. 1818.

Eaton, A.—Geological Text-book (for America.) 8vo. Albany, U.S. 1830.

Ainsworth, W.—Account of the Caves of Ballybunian in the county of Kerry. 8vo. Dublin, 1834.

Exposition des Produits de l' Industrie Française en 1839—Rapport du Jury central. 3 vols. 8vo. Paris, 1839.

Treatise on Calico Printing. 12mo. 1793.

Black, W.—A Practical Treatise on Brewing. 8vo. 1835.

Moseley, B.—A Treatise on Sugar. 8vo. 1799.

Curr, J.—Railway Locomotion and Steam Navigation: their Principles and Practice. 8vo. 1847.

Hall, Mr.—The principal Roots of the Latin Language. 8vo. 1825.

Roberts, T.—An English and Welsh Vocabulary. 12mo. 1827.

Forde, W.—The True Spirit of Milton's Versification developed. 8vo. 1831.

Schweigger, J. S. C.—Einleitung in die Mythologie. 8vo. Halle, 1836.

Fellows, Sir Charles, V.P.R.I. (the Author)—Coins of Ancient Lycia before the reign of Alexander: with an Essay on the relative dates of the Lycian Monuments in the British Museum. 8vo. 1855.

Franklin Institute of Pennsylvania—Journal, Vol. XXIX. Nos. 4, 5. 8vo. 1855.

Geological Society—Quarterly Journal, No. 42. 8vo. 1855.

Graham, George, Esq. Registrar-General—Reports of the Registrar-General for May, 1855. 8vo.

Hamilton, W. J. Esq. Pres. Geol. Soc. (the Author)—Address at the Anniversary Meeting of the Geological Society, Feb. 16, 1855. 8vo. 1855.

Hopkins, Thomas M. Esq. (the Author)—On the Atmospheric Changes which produce Rain and Wind. 2nd Ed. 8vo. 1854.

Horticultural Society of London—Journal, Vol. IX. Part 4. 8vo. 1855.

Ingall, G. H. Esq.—The History of Britain. By John Milton. 4to. 1670.

moment of induction, is discharged back again at the same place the instant the induction is over; the first discharge heats and prepares the air there for the second discharge, and the two are so nearly simultaneous as to produce the appearance of a single spark to the unaided eye.

Reference was then made to the hopes raised by this instrument, of advance in the investigation of the magneto-electric power, by means of the great aid which it seems competent to supply. The results obtained by Grove* apparently referable to polarization were adverted to; as also the remarkable transverse bands presented in the recurring discharge across very rarified air†; and, founded as the instrument is by its core and its wires upon the joint effects of electro-dynamic and magneto-electric induction, it was observed that it gave great promise of aid in the investigation of that condition of either the space or the ether which is about magnets, and around every discharge of electricity, whether in good or bad conductors, and which is expressed by the terms (themselves synonymous) of the magnetic or the electrotonic state.

[M. F.]

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* Phil. Trans. 1852, p. 93, &c.

† Phil. Mag. 1852, iv, p. 514.

Royal Institution of Great Britain.

1855.

WEEKLY EVENING MEETING,

Friday, June 15.

H.R.H. The Prince Albert, K.G. F.R.S. Vice-Patron R.I., in the Chair.

Colonel H. C. Rawlinson,

On the Results of the Excavations in Assyria and Babylonia.

These excavations, independently of the treasures of art disclosed by them, have opened up to us a period of about 2000 years in the world's history, which, as far as the East is concerned, was before almost entirely unknown. The cuneiform inscriptions of Babylonia and Assyria furnish a series of historical documents from the 22nd century B.C. to the age of Antiochus the Great. The speaker divided these documents into three distinct periods of history, the Chaldæan, the Assyrian, and the Babylonian, and he then proceeded briefly to describe each period in succession. During the Chaldæan period the seat of empire was to the south, towards the confluence of the Tigris and Euphrates, and the sites of the ancient capitals were marked by the ruins of Mugheir, of Warka, of Senkereh, and of Niffer. At Mughier, called in the inscriptions *Hur*, and representing the biblical *Ur* of the Chaldees, inscriptions have been found of a king, "*Kudur*, the conqueror of Syria," who was probably the Chedorlaomer of the Bible. At any rate, a king named *Ismi-Dagan*, who lived some generations later, is proved, by a series of chronological dates found in the Assyrian tablets, to belong to the 19th century B.C., so that the era of the earlier king agrees pretty well with the ordinary computation of the age of Abraham. The names of about twenty-five kings have been recovered of the ancient period, and there are good grounds for believing that the Assyrians did not succeed in establishing an independent empire at Nineveh till the early part of the fifteenth century B.C.

From B.C. 1273 to 625, the Assyrians seem to have been the lords paramount of Western Asia, and their history is preserved

exhibited, for the purpose of proving experimentally some of the assertions made by the speaker in reference to this subject. A cube of bismuth was taken and suspended by a twisted string between the two poles of an electro-magnet. The cube was attached by a short copper wire to a little square pyramid, the base of which was horizontal, and its sides formed of four small triangular pieces of looking-glass. A beam of light was suffered to fall upon this reflector, and as the reflector followed the motion of the cube the images cast from its sides followed each other in succession, each describing a circle of about 30 feet in diameter. As the velocity of rotation augmented, these images blended into a continuous ring of light. At a particular instant the electro-magnet was excited, currents were evolved in the rotating cube, and the strength of these currents, which increases with the conductivity of the cube for electricity, was practically estimated by the time required to bring the cube and its associated mirrors to a state of rest. With bismuth this time amounted to a score of seconds or more: a cube of copper, on the contrary, was struck almost instantly motionless when the circuit was established.

[J. T.]

GENERAL MONTHLY MEETING,

Monday, February 4.

William Pole, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

George Busk, Esq. F.R.S. F.R.C.S.
Major-General Anthony Emmett, Royal Engineers, and
William Baker Taylor, Esq. Surgeon-General, Bombay Army,

were duly *elected* Members of the Royal Institution.

Thomas Farquhar Hill, Esq. and
Jonathan Rigg, Esq.

were *admitted* Members of the Royal Institution.

The following Presents were announced, and the thanks of the Members were returned for the same:—

From—

H.R.H. Prince Albert, *K.G. F.R.S. Vice-Patron, R.I.*—W. Macgillivray, Natural History of Dee-Side and Braemar. Edited by E. Lankester, M.D. 8vo. 1855.

3,300,000 fresh men, pledged to exert their fullest strength through 20 years. Her actual annual expenditure of power, then, is represented by 66,000,000 of able-bodied labourers. The latent strength resident in the whole coal product of the kingdom may, by the same process, be calculated at more than 400,000,000 of strong men, or more than double the number of the adult males now upon the globe.

Climates.—Adverting to the causes of the characteristic features of the North American climates, those of all the eastern and northern divisions of the continent were shown to depend primarily upon the peculiar distribution of the land and water, and the general circulation of the winds and oceanic currents in the North Atlantic and the Polar Basins, resulting from general phenomena of rotation of the fluids, and from the configuration of those seas. The chief surface currents of both these basins belong all to one great circulating stream, which, crossing the Atlantic from Africa to the Gulf of Mexico, under the northern tropic, and following for a vast distance the highly-heated shores of South and Central America, enters the North Atlantic at Florida, under the name of the Gulf Stream, carrying a temperature 5° to 6° higher than the mean heat of the equator, and imparting to the southern coast of the United States the ocean temperature of the tropics. Pursuing its career to the north-east, this current transports its own mild climate to the whole north-western side of Europe, and even subdues the rigours of the European Polar sea; but refrigerated, as it sweeps round in its circumpolar course, the shores of Siberia and Western Arctic America; and, loaded with the annual ice of all that extended zone, it streams through the great Archipelago of North-eastern Arctic America, clogs its deep channels with its floating packs of ice, and chills to the zero temperature of the whole hemisphere this coldest of all the summer climates of the globe. Returning into the Atlantic around Greenland, and by its main passage through Baffin Bay, this now arctic ice-chilled and ice-transporting current, hugs the whole north-eastern coast of the continent inside of the Gulf Stream. It thus weaves a track somewhat resembling the figure 8. The Gulf Stream on the south-east, and the Arctic current on the north, conjointly with the tropical and the polar winds with which they are connected, produce such a contrast in the temperature of the southern and northern latitudes of eastern America, that all the zones of the climates of the sphere are there compressed within not more than 30° of a great circle, crossing the continent from the Gulf Stream to lat. 70° north of Hudson Bay.

The climatology of the western half of the continent was next discussed. There the controlling agent in the latitudes north of the north-east Trade Wind of the tropic, is the south-west and west wind from the Pacific Ocean, and in the Southern Atlantic States from the Gulf of Mexico. This Pacific Ocean wind, moderately charged with moisture in the lower latitudes, and excessively humid in the

tube. The anhydrous chloride was thus evolved in vapour, and condensed in a suitable receiver. The apparatus contrived by M. Deville for procuring this substance, and described in the memoir already referred to,* was exhibited. Wöhler's process of obtaining aluminium from its chloride is well known. The following modification of that process, devised by M. Deville, was shown in action.

A tube of Bohemian glass, 36 inches long, and about one inch in diameter, was placed on an empty combustion-furnace, constructed for the purpose. Chloride of aluminium was introduced at one extremity of the tube; at the same extremity a current of dry hydrogen gas was made to enter the tube, and was sustained till the operation was finished. The chloride was now gently warmed by pieces of hot charcoal, in order to drive off any hydrochloric acid it might contain; porcelain boats, filled with sodium, were inserted into the opposite extremity of the tube; the heat was augmented by fresh pieces of glowing charcoal until the vapour of the sodium decomposed that of the chloride of aluminium. Intense ignition usually attends this re-action. At length the aluminium was liberated in buttons, which were found in the boat adhering to a substance consisting of the mixed chlorides of aluminium and sodium. The boat was now transferred, with its contents, to a porcelain tube, through which hydrogen gas was passed. At a red heat, the double chloride distilled into a receiving vessel, attached to the tube for the purpose; the buttons of aluminium were collected, washed with water, and subsequently fused together under a flux consisting of the double chloride.

Another method of obtaining aluminium from the chloride has been adopted with success. It is as follows:—

4·200 grammes of the double chloride of aluminium and sodium (*i.e.*, 2·800 grammes chloride of aluminium, and 1·400 grammes common salt),
2·100 grammes of common salt,
2·100 grammes of cryolite,

thoroughly dry, and carefully mixed together, are to be laid in alternate layers, with 840 grammes of sodium (cut into small pieces), in a crucible lined with alumina—a layer of sodium should cover the bottom of the crucible. When the crucible is filled, a little powdered salt is to be sprinkled on its contents, and the crucible, fitted with a lid, is to be introduced into a furnace, heated to redness, and kept at that temperature until a reaction, whose occurrence and continuance is indicated by a peculiar and characteristic sound, shall have terminated. The contents of the crucible, having been stirred with a porcelain rod, while in their liquified state—(this part of the operation is essential)—are poured out on a surface of

* Recherches sur les Métaux, &c.

composed. The relation between the amount of light and the amount of decomposition was found in this case not to be a simple one.

This anomalous action may be explained even from a theoretical point of view. Chemical affinity is the resultant of all the forces which come into play during the reaction; hence it is not only the interchanging atoms which influence the result, but also those atoms which, without taking part in the decomposition, surround those actively engaged. The so-called catalytic phenomena show this action in a striking manner. To apply this general principle to the special case before us; we have to begin with pure chlorine water; after the first action of the light, however, hydrochloric acid is formed, hence the composition of the solution is altered, and a different result must be expected. This theoretical conclusion was verified by experiment. Chlorine water, to which 10 per cent. of hydrochloric acid was added, did not suffer any decomposition by an exposure of six hours to the direct sunlight; during which time the same chlorine water, without previous addition of hydrochloric acid, lost nearly all the free chlorine which it contained.*

In order then to obtain a true measure of the action of light on any chemical substance, it is necessary that the body formed by the decomposition should be removed from the sphere of action. This cannot be done with chlorine water; a new sensitive substance was therefore employed.

Equal volumes of chlorine and hydrogen gases when exposed to the direct sun light unite with explosion; in diffuse light, the action proceeds gradually. In presence of water the hydrochloric acid formed by the combination is immediately absorbed, and thus withdrawn from the sphere of action, and the diminution of the volume of the mixed gases arising from this absorption gives an exact measure of the amount of action effected by the light. The diminution in volume of the gas measured by the rise of water in a graduated tube was found to be regular, proving *that when the light is constant the amount of action is directly proportional to the time of exposure.*

The relation between the amount of action and the amount of light was experimentally determined, by allowing known quantities of diffuse light to fall upon the sensitive gas. Experiments thus conducted showed *that the amount of action is directly proportional to the amount or intensity of the light.* These simple relations were observed by Dr. Draper, of New York, in 1843; but his method of experimenting differed essentially from that employed in these researches, and was not susceptible of any very great degree of accuracy. The relation between the amount of action and the mass of the sensitive gas has not as yet been fully determined; experi-

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* See Poggendorff's Annalen, xcvi., 373; and Quarterly Journal of Chemical Society, Oct. 1855.

Astronomical Society, Royal—Monthly Notices. Vol. XVI. Nos. 4, 5. 8vo. 1856.
Author—Two Letters (on Educating the Deaf). 8vo. 1856.
Babbage, Charles, Esq. F.R.S. (the Author)—Observations (on Mr. Scheutz's Calculating Machine) at the Anniversary of the Royal Society, 1855. 8vo. 1856.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for April 1856. 8vo.
Boosey, Messrs. (the Publishers)—The Musical World for March 1856. 4to.
Botfield, Beriah, Esq. F.R.S. M.R.I. (the Author)—Some Account of the first English Bible: and of Early English Books, printed on Vellum. 4to. 1856.
Bradbury, Henry, Esq. M.R.I.—The Ferns of Great Britain and Ireland. By T. Moore, F.L.S. Edited by J. Lindley, Ph.D. F.L.S. Part 12. fol. 1856.
British Architects, Royal Institute of—Proceedings in March 1856. 4to.
British Meteorological Society—Fourth Report read at the Annual Meeting, 1855. 8vo.
Civil Engineers, Institute of—Proceedings in March 1856. 8vo.
Cardale, John Bate, Esq. M.R.I.—The Liturgy and other Divine Offices of the Catholic Apostolic Church (Gordon Square). 8vo. 1853.
Editors—The Medical Circular for March 1856. 8vo.
The Practical Mechanic's Journal for March 1856. 4to.
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The Mechanic's Magazine for March 1856. 8vo.
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The Engineer for March 1856. fol.
Faraday, Professor, D.C.L. F.R.S.—Monatsberichte der Königl. Preuss. Akademie, Jan. 1856. 8vo. Berlin.
Franklin Institute of Pennsylvania—Journal, Vol. XXXI. Nos. 2, 3. 8vo. 1856.
Geological Society—Quarterly Journal, No. 45. 8vo. 1856.
Graham, George, Esq. (Registrar-General)—Report of the Registrar-General for March 1856. 8vo.
13th, 14th, 15th, and 16th Annual Reports, for 1850–3. 8vo. 1854–6.
Granville, Rev. A. H. B. A.M.—How to settle the Church Rate Question. 8vo. 1856.
Granville, A. B. M.D. F.R.S.—Fresh Analyses of the Kissingen Mineral Waters. 1856.
Johnson, Edmund C. Esq. M.D. M.R.I.—The Life and Times of Marlborough and Wellington. By Viscount Cranborne. 8vo. 1856.
Jopling, J. Esq. (the Author)—Key to the Proportions of the Parthenon. 8vo. 1856.
Lewin, Malcolm, Esq. M.R.I. (the Author)—On Torture in Madras, &c. 8vo. 1856.
Londesborough, The Lord, K.H. M.R.I.—Miscellanea Graphica, Part 8. 4to. 1856.
Newton, Messrs.—London Journal (New Series), April 1856. 8vo.
Novello, Mr. (the Publisher)—The Musical Times, for March 1856. 4to.
Petermann, A. Esq. (the Author)—Mittheilungen auf dem Gesammtgebiete der Geographie. 1856. Heft 1. 4to. Gotha, 1856.
Photographic Society—Journal, No. 40. 8vo. 1856.
Royal Society of London—Proceedings. No. 19. 8vo. 1855-6.
Society of Arts—Journal for March 1856. 8vo.
Smith, W. A. Esq. M.R.I. (the Author)—A last Appeal! War—Peace, or an Armed Truce. 8vo. 1856.
Statistical Society—Journal, Vol. XIX. Part 1. 8vo. 1856.
Taylor, Rev. W. F.R.S. M.R.I.—Engraving and Description of Cowthorpe Oak, Yorkshire. By C. Empson. 4to. 1842.
Trustees of the British Museum—Catalogue of Shield Reptiles, with Engravings. Part 1. By J. E. Gray. 4to. 1855.
Van Diemen's Land, Royal Society of—Papers, &c. Vol. II. Part 3. 8vo. 1854.
Tasmanian Contributions to the Paris Exhibition. fol. 1855.

The steam-engine of Watt was composed of four organic parts, which were pointed out on a working model before the meeting, namely:—1. The furnace, or chamber of combustion, with its flues and chimney. 2. The boiler, or steam generator. 3. The steam-vessel, or cylinder, wherein the elastic force of the steam is imparted to the piston, or other first moving parts of the machinery. 4. The condenser, where the elastic force of the steam is destroyed by abstracting its latent heat, by injection of cold water, or by exposure of cooled metallic surfaces. In the case of high-pressure engines, it would seem that the condenser was suppressed; but it might be said, that this class of engines makes use of one great common condenser, namely the atmosphere; the separate condenser possessing only the advantage of relieving the working piston of the opposing atmospheric pressure. The only essential improvement of the steam-engine that has been introduced since the time of Watt consists in working the steam expansively, whereby a considerable economy has been attained; but it is well known that Watt foresaw the advantages that would be realised in this direction, and was prevented only by insufficiency of the mechanical means at his disposal from realising the same.

The lofty superstructure proved the soundness of the foundation Watt had laid; and it would seem hopeless to change the same, unless it could be proved that the very principle regarding the nature of heat, whereon Watt had built, had given way to another more comprehensive principle. The engine of Watt was based upon the material theory of heat that prevailed at his time, and almost to the present day. According to this theory, steam was regarded as a chemical compound of water and the supposed imponderable fluid "heat," which possessed amongst others the property of occupying under atmospheric pressure nearly 1700 times the bulk of the water contained in it. The Boulton and Watt condensing engine took the full advantage of this augmentation of volume, which effected a proportionate displacement of piston, and the condensation of the steam obviated all resisting pressure to the piston.

In the course of the last few years our views of the nature of heat had however undergone a complete change; and, according to the new "dynamic theory," heat, as well as electricity, light, sound, and chemical action, are regarded as different manifestations of motion between the intimate particles of matter, and can be expressed in equivalent values of palpable motion and dynamic effect. In support of this theory, he (Mr. Siemens) could not do better than refer to the able discourses, recently delivered in the Royal Institution, by Mr. Grove and Professor Thomson.*

Viewed from the position of the new theory, the heat given out in the condenser of a steam-engine, represented a loss of mechanical

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* See pp. 152 and 199.

Varying Cubic Space.

	Cubic Feet.		Cubic Feet.
In a slave ship, with 311 persons	14	Hospitals, Dundee (old, now destroyed) . . .	398
Best slave ships	28	„ Liverpool . . .	561
Emigrant ships, upper deck .	90	„ Glasgow	750
„ lower do. 7ft. high	126	„ Walton (convalescent)	800
„ „ if under	173	„ Middlesex . . .	1000
H.M.S. Rodney (sleeping space)	76	„ Edinburgh . . .	1090
„ Ariel	94	„ Haslar	1100
„ Ajax	98	„ Westminster . . .	1200
„ Falcon	104	„ Guy's (old wards) .	1200
„ Severn	117	„ Newcastle . . .	1500
„ Pylades	125	„ Dundee (new) . .	1545
„ Duke of Wellington .	128	„ King's College . .	1600
„ Impérieuse	145½	„ St. Bartholomew's .	1650
		„ Guy's (new wards) .	1700
		„ London	1700

As a striking example of the error which prevails regarding the cubic space necessary for health, and as a good instance of the worthlessness of the appeal to practical experience, in many similar cases, I may give the following police regulation for lodging-houses :—

"The space allowed in common lodging-houses for each lodger, in rooms from 5 ft. 6 in. to 6 ft. in height, is 50 superficial feet; and in rooms more than 6 ft. in height, 30 superficial feet are allowed for each lodger.

"This arrangement has been found to work satisfactorily, and to secure the health of the lodgers. Two children under 10 years of age are reckoned as one adult."

Police Allowance in Lodging-Houses.

When 5 ft. 6 in. to 6 ft. high, 50 superficial feet = 275 to 300 cubic feet.
When 6 ft. 1 in. high, 30 „ = 183 cubic feet.

That is, rooms from 5 ft. 6 in. to 6 ft. high give from 275 to 300 cubic feet for each person; and if 6 ft. 1 in. high, then only 183 cubic feet are given.

To obtain an equal amount of cubic feet of air the rooms should be between 9 and 10 ft. high. The police rule is, however, justified by experience! "This arrangement has been found to work satisfactorily, and to secure the health of the lodgers." This does not prove the truth of the rule, but only that there is some great mistake in the rule.

What rule then must be made? It appears to me that instead of taking the cubic contents of a room as the guide, the ventilation and the square contents, or in other words, the change of air and the size of the floor, can alone determine the number of persons *that can safely* and properly be admitted into any space.

there ought to be a whole year's unfrozen fissures in the ice. Such fissures surely would not require the act of freezing to render them visible; they would be seen when filled with blue water just as well as when filled with blue ice. But they never have been observed; and it is therefore to be inferred that they have no existence. With regard to the drag towards the centre, which is supposed to arise from the viscosity, and in which direction it is stated that "filaments slide past each other," it is by no means clear on mechanical grounds that such a drag exists. For the transfer of matter from the sides to the centre, in consequence of such a drag, must finally absorb the former, unless to make good the loss a motion in some other portion of the glacier from the centre to the sides, that is in a direction opposed to the theory, be established. Let the line A B, (Fig. 1) represent the centre of a glacier; C D its side, and *a* a point between both. Draw *m n*, *o p*, making

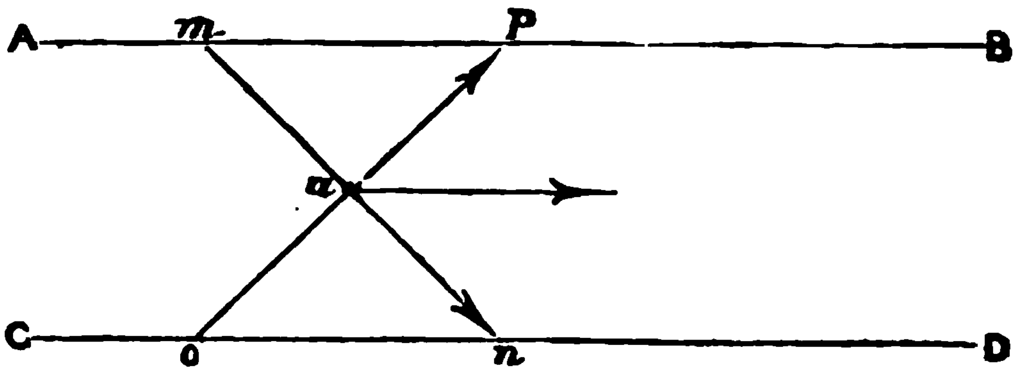
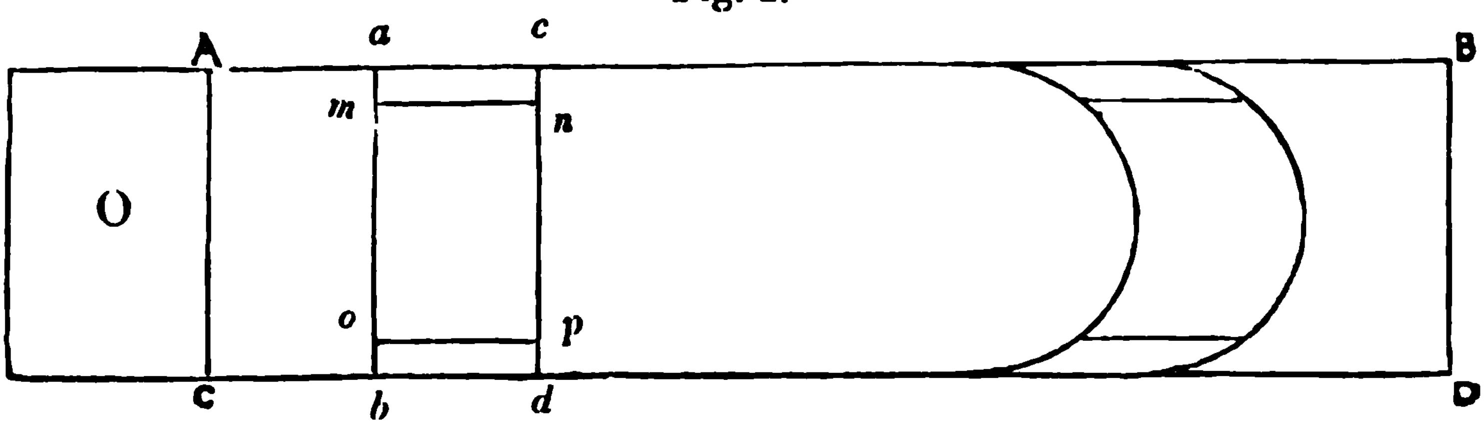


Fig 1.

equal angles with the centre and side. In consequence of the quicker flow of the centre the line *m n* tends to shorten itself, causing a *thrust* on the point *a*, which urges it towards the side C D; the line *o p* for the same reason tends to elongate itself, which produces a *drag* of the point *a* towards the centre. The point *a* is here solicited by two equal forces, and the resultant motion will be along the line A B, parallel to the length of the glacier. This result receives the most complete confirmation from observation, so that the drag towards the centre expresses only half the conditions of the problem.

To test the question on a small scale, the following experiment

Fig. 2.



was made, A B C D, (Fig. 2) is a wooden trough, six feet long, and one foot wide. The end, A C, of the trough is elevated. O is a

Varro, and Columella. These books will make them in time masters of any ordinary Latin prose, and will be at the same time "occasions of inciting and enabling them hereafter to improve the tillage of their country." The use of maps and globes is to be learnt from modern authors; but Greek is to be studied, as soon as the grammar is learnt, in the "historical physiology of Aristotle and Theophrastus." Latin and Greek authors together are to teach the principles of arithmetic, geometry, astronomy, and geography. Instruction in architecture, fortification, and engineering, follows. In natural philosophy we ascend through the history of meteors, minerals, plants, and living creatures to anatomy. Anatomy leads on to the study of medicine.

The objections to some of these plans are too obvious to need any notice. No one will suppose that natural philosophy is to be learnt from Seneca, or agriculture from Columella. Every one will admit readily that his own amazing powers of acquisition led Milton to overrate the powers of ordinary boys. But it would seem a poor reason for not availing ourselves of the hints that he gives us, that we have means of following them out which he had not: a poorer reason still for not profiting by the warnings which he gives us against filling our pupils' heads with a mere multitude of words, that he perhaps asked them to take in more both of words and things than they would be able comfortably to carry. If he is an idealist, he is certainly also a stern realist. He would have us always conversant with facts rather than with names. He aims at the useful as directly as the most professed utilitarian. The pupils are to have "the helpful experiences of hunters, fowlers, fishermen, shepherds, gardeners, and apothecaries," to assist them in their natural studies. These studies are to increase their interest in Hesiod, in Lucretius, and in the Georgics of Virgil. The incentive for studying medicine is, that they may perhaps "save armies by frugal and expenseless means, and not let the healthy and stout bodies of young men under them rot away for want of this (medical) disçipline."

Two other objections have been raised by Dr. Johnson against this scheme of education. The first will, probably, not have great weight with the members of the Royal Institution, for it turns upon the comparative worthlessness of the physical sciences. The other is expressed in some very elegant sentences, maintaining that the formation of a noble and useful character is the true end of education. One cannot help deploring that maxims so good and well-delivered should be so utterly thrown away. They are absurdly inapplicable to Milton's letter. It is throughout a complaint that the existing education was not sufficiently directed to the purpose of forming brave men and good citizens. It is throughout an assertion that that is the only purpose which any education ought to aim at. The classics are not resorted to for the purpose of forming a style, but of instilling manly thoughts, which a higher wisdom may purify

Savage's work "On the Art of Decorative Painting," published in 1822, with additional Illustrations.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM

Her Majesty's Government—Catalogue of Stars near the Ecliptic, observed at Markree, 1854-6. 8vo. 1856.

East India Company, the Hon.—Rig Veda Sanhita. Edited by Dr. Max Müller. Vol. III. 4to. 1856.

Lords of the Admiralty—The Nautical Almanac for 1857–60. 8vo.

Académie des Sciences de l'Institut Impérial de France—Mémoires présentés par Divers Savans. Tome XIV. 4to. 1856.

Mémoires. Tome XXVII. Partie 1. 4to. 1856.

Supplément aux Comptes Rendus. Tome I. 4to. 1856.

Actuaries, Institute of—Assurance Magazine. No. 26. 8vo. 1857.

Art-Union of London—Report for 1856. 8vo.

Almanacs for 1857. 8vo.

Asiatic Society of Bengal—Journal, No. 257. 8vo. 1855.

Astronomical Society, Royal—Monthly Notices. Vol. XVII. Nos. 1, 2. 8vo. 1856.

Babbage, Charles, Esq. F.R.S. (the Author)—Analysis of the Statistics of the Clearing-house during 1839. 8vo. 1856.

Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for Jan. 1857. 8vo.

Boosey, Messrs. (the Publishers)—The Musical World for Jan. 1857. 4to.

British Architects, Royal Institute of—Proceedings in Jan. 1857. 4to.

British and Foreign Bible Society—Catalogue of their Library, by G. Bullen. 8vo. 1857.

Carpenter, W. B. M.D. F.R.S. (the Author)—Researches on the Foraminifera. Part 2. 4to. (Phil. Trans.) 1856.

Copland, James, M.D. F.R.S. (the Author)—On the Drainage and Sewage of London. 12mo. 1857.

De la Rue, Warren, Esq. F.R.S. M.R.I.—Engraving of Jupiter, as seen with a Newtonian Equatoreal of 13 inches aperture, Oct. 25, 1856.

Editors—The Medical Circular for Dec. 1856, and Jan. 1857. 8vo.

The Practical Mechanic's Journal for Dec. 1856, and Jan. 1857. 4to.

The Journal of Gas-Lighting for Dec. 1856, and Jan. 1857. 4to.

The Mechanic's Magazine for Dec. 1856, and Jan. 1857. 8vo.

The Athenæum for Dec. 1856, and Jan. 1857. 4to.

The Engineer for Dec. 1856, and Jan. 1857. fol.

The Literarium for Dec. 1856, and Jan. 1857.

Faraday, Professor, D.C.L. F.R.S.—Monatsberichte der Königl. Preuss. Akademie, Sept. und Okt. 1856. 8vo. Berlin.

Franklin Institute of Pennsylvania—Journal, Vol. XXXI. No. 5; and Vol. XXXII. Nos 3, 4, 5, 6. 8vo. 1856.

Gamgee, Joseph S., Esq. (the Author)—Researches in Pathological Anatomy and Clinical Surgery. 8vo. 1856.

On the Advantages of the Use of the Starched Apparatus in the Treatment of Fractures, &c. 8vo. 1853.

Reflections on Petit's Operation. 8vo 1855.

Osservazioni sul Regime Dietetico. 8vo. 1853-4.

Geographical Society, Royal—Proceedings, No. 6. 8vo. 1857.

Gladstone, Dr. J. H. F.R.S. M.R.I. (the Author)—Papers on Chemical Affinity, &c. 4to. and 8vo.

Glösener, M. (the Author)—Recherches sur la Télégraphe Electrique. 8vo. Liége, 1855.

Graham, George, Esq. (Registrar-General)—Report of the Registrar-General for Dec. 1856, and Jan. 1857. 8vo.

WEEKLY EVENING MEETING,

Friday, February 6.

Sir Benjamin Collins Brodie, Bart. D.C.L. F.R.S.
Vice-President, in the Chair.

John Hall Gladstone, Ph.D. F.R.S. M.R.I.

On Chromatic Phenomena exhibited by Transmitted Light.

The origin of colour was first illustrated by some elementary remarks and experiments. It was laid down as a fundamental principle, that the colour of an object depends on its reflecting or transmitting those rays of light which are capable of producing the sensation of the said colour. The objection that a rose is red not only when viewed by red light, but when seen in colourless daylight, was answered by showing that a beam of colourless light from the electric lamp really consisted of very many coloured rays, and was resolvable by a prism into a red, orange, yellow, green, blue, indigo, and violet light. This, when received on a white screen, showed a brilliantly coloured spectrum, and brightly tinted objects appeared of their ordinary hue only when illuminated by the ray of the same colour. It was explained that the electric light closely resembles that of the sun, but that the light of the great luminary is deficient in certain rays, so that a prismatic spectrum formed by daylight is traversed by very thin dark lines, which have been mapped and designated A, B, C, D, &c. Most artificial lights contain certain coloured rays in excess, hence objects illuminated by them exhibit that colour more prominently than by daylight. The soda flame, for instance, consists almost wholly of certain yellow rays which are wanting in the sun's light, coinciding in refrangibility (as Mr. Crookes has shown) with the dark line D; hence red or blue objects illuminated by it appear black, and nothing is reflected from those which do appear luminous excepting a ghastly yellow.

Leaving reflected, and turning to transmitted light, it was seen that pieces of coloured glass, interposed in the beam of light from the electric lamp, stopped certain rays, while they allowed others to pass through; thus a red glass cut off all the blue end of the spectrum, while a smalt-blue glass divided the red end into several

the general rule; yet a solution of yellow chromate of potash appeared scarcely any paler when diluted with perhaps twenty times its bulk of water. Sometimes also a complete change of colour takes place; thus acetate of chromium, which was red, became green when considerably diluted with pure water: a few drops of cochineal, stirred up in a tall champagne glass filled with water, imparted a red tint to the upper wide portion, and a lavender tint to the lower and narrow portion. A neutral solution of litmus is blue, alkalies render this (as is well known) still more blue, boracic or carbonic acid changes it to a wine red, and other acids to a bright red: yet slightly acid litmus was exhibited of a pale purple hue, and alkaline litmus of a deep red colour. All these phenomena were stated to be dependent, not on any chemical action exerted by the water, but on the quantity of the colouring substance traversed by the light in its passage to the eye; the same solution appearing of different colours according to the thickness seen through, and a deep stratum of a dilute liquid having the same tint as a shallow stratum of the same liquid when strong. The speaker added, that this phenomenon had been fully described and explained by Sir John Herschel, who termed it Dichromatism, but that fresh instances of it were being constantly observed; indeed, after investigating some cases of it last summer, he had, during a tour on the continent, noticed a fruit sauce which constantly appeared at the hotel dinners in Bavaria and other parts of Germany, and was beautifully dichromatic, red and blue, with every intervening shade of purple. By this character he had traced its composition, and found the colour was due to the deep red cherries which were very abundant at that season. He had noticed the phenomenon likewise in some specimens of the ordinary wine, in essence of lavender, in the syrup of green-gage tart, as well as in some pure chemical substances, such as red prussiate of potash, meconate of iron, purple comenamate of iron, citrate of iron, sulphindigotic acid, and permanganate of potash.

The prism reveals the origin of all these chromatic phenomena. It shows that the different rays of the spectrum are capable of penetrating different distances into a coloured medium. Thus, if port wine be placed in a wedge-shaped glass vessel, and this interposed in the refracted rays in such a position that each coloured ray can fall upon the different thicknesses of the liquid, it will be found that all the rays of the spectrum can penetrate a thin stratum, but that as the liquid increases in depth all are absorbed except the least refrangible red. Hence the thin film of a bubble of port is colourless. If yellow chromate of potash be examined in a similar manner, it is found to cut off the blue and violet rays at once, and to transmit the less refrangible half of the spectrum with equal freeness whether the stratum be thin or thick. Hence it is that dilution scarcely diminishes the colour of this dissolved salt. If a wedge of cobalt-blue glass (which is dichromatic) be inter-

jective origin. Difficulties of another character have also been urged against Brewster's deduction, by Helmholtz and others, and may be drawn from Maxwell's experiments. It is certain that changes in the apparent colour of a particular ray may arise from other causes than the absorption of one kind of light, while another kind having the same angle of refraction is transmitted. Of these may be enumerated :—First, an actual change of refrangibility, as in the cases of "fluorescence," so fully investigated by Professor Stokes. Secondly, a difference in the impression on the sense, arising from change of intensity. Thus blue, if very luminous, inclines to white, if faintly luminous to violet; and so the fore-mentioned note-book designates the faint rays about F that were transmitted by the red bell-glass, "lilac," and the speaker had observed the blue in the prismatic spectra given by ammonio-sulphate of nickel, and by tincture of lavender, gradually shading off into violet as the light passed through deeper strata of liquid. The yellow of the solar spectrum appears to occupy a considerable space, if the sun be bright, but if diffuse daylight be examined, that space appears orange and green, while the yellow is perhaps confined to a very luminous line a little beyond D. It is not to be wondered at therefore that the green in the spectra of port wine and of citrate of iron, appears to invade the space usually occupied by the yellow, and the orange yellow. Yet in such cases the impression on different eyes may be very different; thus, in rehearsing the experiments with the electric light at the Royal Institution, Dr. Gladstone had seen the bright space beyond D transmitted by blue glass of a decidedly green tint; but Mr. Anderson had unhesitatingly called it yellow, its proper colour. This difference of sensation, arising from difference of intensity, was illustrated by the "Cercles chromatiques" of M. Chevreul, the first of which represents the bright colours of the spectrum, in which that called "*Jaune*" is certainly a beautiful yellow; but the succeeding circles represent the same, reduced by the admixture of various percentages of black, and in them the "*Jaune*" becomes *green*, and so likewise does the "*Orange*," where a very large proportion of black has been added. A revolving disk, coloured black, on which had been fastened a segment of bright yellow paper, appeared uniformly green when set in rapid motion. Again, on one of Maxwell's colour tops was fixed an outer circle of red, and an inner one, partly black and partly orange; when the top was spun the inner circle appeared green. Thirdly, contrast will frequently change the apparent colour of a particular ray. The result in the last experiment was partially due to this cause, the outer circle of bright red facilitating the sensation of its complementary colour green. Thus the dim light between D and E in the spectrum of ammonio-sulphate of nickel, with bright orange on one side and green on the other, assumes a very indefinite tint. The very remarkable prismatic image given by a solution of permanganate of potash in

The *first* method, in which light was used to aid the engraver's art was almost coeval with the first attempts made to produce sun-drawn pictures. Indeed it had been asserted that photography and photographic engraving were invented between the years 1813 and 1827, by one man, Nicéphore Niepce, of Chalon on the Saône. A reference, however, to the Journal of the Royal Institution* would show that photography really sprang from the labours of Thomas Wedgwood and Humphry Davy, as far back as the year 1802.

Although we cannot accord to Nicéphore Niepce the merit of originating photography, we must give him the undivided title of founder of the art of photographic engraving, and, moreover, acknowledge that he was the first to fix not only a *direct positive* photograph, but also to secure on metal and glass plates the images of the camera, and this long before Daguerre produced his wonderful plates. Of this there can remain no doubt, after a study of the remarkable specimens which Dr. Robert Brown has so kindly enabled photographers now for the first time publicly to examine. It was not generally known that Niepce's images of 1827 had so much that is beautiful, in common with the daguerreotype of a later date. Daguerre's pictures may be said to be only exalted examples of the same phenomenon: yet the processes are widely different. Niepce's method was beautifully simple, and as it gives us the ground-work of his etching process, must be briefly described. He took a bituminous substance called jew's pitch or asphaltum; upon this he poured oil of lavender to resolve the bitumen into a varnish with which he could coat plates of metal or glass. He used chiefly pewter and copper plated with silver. A plate coated and dried was exposed to the light with an engraving superimposed, or it was placed in the field of the camera obscura just as Wedgwood and Davy placed their prepared papers; and with a certain similarity of result, inasmuch as a photographic image was obtained on the varnished plate. This image, however, unlike that of Wedgwood and Davy, was *not visible*. The plate had to be submitted to the solvent action of a mixed liquid, composed of one part of oil of lavender and ten parts by measure of *white oil of petroleum*, or mineral naphtha. On immersion in this fluid the remarkable fact revealed itself, that wherever the light had acted the varnish had become insoluble, and in a certain degree proportionately so to the intensity of the light. There were not only lights and shadows but half tints. The picture, as soon as developed by the solvent, was removed, drained, and washed with water to check all further action. The shadows of the picture were now represented by the parts of the white metal, or glass plate laid bare; the lights were given by the film of varnish which the light had hardened, and the solvent had left untouched. The plate now finished was capable of being etched by simply pouring engraver's acid upon its surface. The

* Journal of the Royal Institution, Vol. I. p. 170.

worthy of further investigation. Here the image is truly drawn by light and *engraved by electricity*.

M. Fizeau, about the year 1844, also patented in this country, in conjunction with M. Claudet, a process for engraving the daguerreotype image. The speaker was instructed in this process by M. Fizeau, and worked for many months at its perfection. Results obtained both in France and England were upon the table, and showed that in cases where great delicacy of delineation was required, as in certain anatomical subjects, this process had not been surpassed. It quite justified the formation of a second division of the available photographic engraving processes.

M. Fizeau, like Mr. Grove, availed himself of the affinity of chlorine for silver, but relied on chemical action for its application. He (M. Fizeau) made a solution of common salt and nitrite of potash in water, to which he added nitric acid. This mixed acid acted immediately when aided by warmth, upon the silver of Daguerre's plate, and left untouched the parts supposed to be completely covered by mercury. Chloride of silver was thus at once formed in the shadows of the images, and after some time in the half tints also. A very faint etching was thus produced. A prolonged application of the acid would not further deepen the etching, since the insoluble chloride of silver at first formed protected the faintly etched parts from a further deepening corrosion. It was therefore necessary to remove the chloride of silver by washing with a solution of ammonia. This effected, the plate was ready for a second application of the acid, when chloride of silver would be again formed, to be once more removed by ammonia; and this alternation of solutions could be repeated a certain number of times, the etching increasing in depth at each operation. But in practice it was found that after a few applications of the acid the lights of the image also gave way, and thus the engraving came to an untimely end. To remedy this circumstance was M. Fizeau's great aim; and he succeeded in a marked degree by heating the etched plate in a strong and boiling solution of caustic potash, after which treatment the lights resisted well the injurious action they had before suffered from. It is not clear how the potash acts. M. Fizeau has supposed, and the speaker was inclined to support the view, that the potash acts merely as a hot bath, possessing a proper and a regular temperature which might restore the continuity of the amalgamated surface of mercury and silver as often as it was weakened to the point of breaking by the *under-biting* of the acid liquid. The heating in potash is an important feature in M. Fizeau's process. As soon as the etching has been carried as far as possible by the acid mixture, the plate is dried and inked with fine printer's ink, and an impression may be immediately taken; but M. Fizeau prefers that the ink should be allowed to dry in the hollows of the plate, the unetched parts being wiped clean, so that gold may be deposited only upon the bright parts by the electrotype process.

GENERAL MONTHLY MEETING,

Monday, March 2.

William Pole, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

Edward Richards Adams, Esq. M.A.
Lieut.-Col. F. St. Leger Alcocke.
Neil Arnott, M.D. F.R.S.
Major Lewis Burroughs.
John Clutton, Esq.
Edward Cotton, Esq.
Charles Alfred Elliott, Esq.
Rev. Robert Everest, F.G.S. F.Stat.S.
Frederick Gray, Esq.
Thomas Williams Helps, Esq. M.A.
Miss Elizabeth C. C. Latter.
George Matthey, Esq.
John Monk, Esq.
Dr. Alphonse Normandy.
Lady Pollock.
Rev. William Rogers.
Russell Scott, Esq.
Alexander Trotter, Esq.
William Trotter, Esq.
Mrs. Sarah Tomlinson.
Edward Vivian, Esq.
Richard Henry S. Vyvyan, Esq. and
Edward Orange W. Whitehouse, Esq.

were duly *elected* Members of the Royal Institution.

John Lister, Esq. and
Joseph Wood, Esq.

were *admitted* Members of the Royal Institution.

The following Presents were announced, and the thanks of the Members returned for the same :—

From—

Agricultural Society, Royal—Journal, Vol. XVII. Part 2. 8vo. 1857.
Astronomical Society, Royal—Monthly Notices, Vol. XVII. No. 3. 8vo. 1857.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for Feb. 1857. 8vo.

sequence of the bell having a much greater power both of bearing blows and of giving out sound than usual; and if we knew nothing more about the matter than that there is one large bell in England which will advantageously bear a clapper twice as heavy in proportion as any other, it would be enough to show that there must be some essential difference between the constitution of that and other bells, which is worth investigating.

The art of bellfounding having sunk so low, as is indicated by what has taken place at the Royal Exchange, and by the great bell of York being not used at all, after having cost £2000, except having the hour struck upon it *by hand* once a-day, it was obviously necessary to begin at the beginning, as we may say, and take nothing for granted as proper to be adopted, merely because we find it in common use now. Accordingly, when I undertook the responsibility of determining the size, and shape, and composition of these five bells, the bellfounders having refused to take any responsibility beyond that of sound casting according to orders, the Chief Commissioner of Works authorised the making of such experiments as might be required before finally determining the design and composition of the bells. Those experiments have only cost about £100, a small sum compared with the value of this one bell, and quite insignificant compared with the importance of success or failure in a national work of this kind. I may observe also, that there is no reason to believe that the art of making large bells is at present in a more flourishing state abroad than here. All the foreign bells in the Great Exhibition of 1851 were bad. Sir Charles Barry and Professor Wheatstone were requested by the Board of Works to make inquiries on the subject at the Paris Exhibition in 1855; and it appears that there is no foreign bellfounder who has cast any bell above a quarter of the weight of the Westminster bell; and the proportions of copper and tin which were stated to be used by the one who has the highest reputation, M. Hildebrand, of Paris, differ from those which I am satisfied are the best, both from the analysis of old bells of great celebrity and from my own experiments. I am equally convinced, that the French shape of bells is not only not the best, but is not so good as what may be regarded as the standard English shape.

I have said already that you may get any depth of note out of a bell of any weight by making it thin enough. At first, everybody who hears a bell, like that which stood at the west end of the Exhibition of 1851, sounding with 29 cwt. very nearly the same note as our 16 ton bell, is ready to pronounce the common form of bell, with a *sound bow* of $\frac{1}{12}$th or $\frac{1}{13}$th of its diameter, a very absurd waste of metal. But did it ever occur to them to consider, how far they could hear that 29 cwt. hemispherical bell? It could not be heard as far as a common bell of 2 or 3 cwt.; and before you get to any great distance from a bell of that kind, the sound becomes thin and poor, and what we call in bell-founding language, potty.

of the Cathedral,) and that of the great bell of Bow, which is probably much the same as that of St. Paul's, York, and Lincoln, as they all came from the same foundry in Whitechapel. Indeed, the sound-bow of this bell is fuller outside than the Paris bell, because it is thicker; so much so, that a straight edge laid externally against the top of the bell and the sound-bow would be thrown out beyond the lip; whereas generally such a straight line would touch the lip, and just clear the sound-bow. Only within the last few days I have found one other remarkable exception to this general rule of construction, and a remarkable coincidence with the external shape, and the proportions of height, breadth, and thickness of our bell, and that is no other than the great bell of Moscow, of which an exact section is given in Lyall's Russia, with various different versions of its weight. The inside shape, however, is not the same, and I am satisfied not so good, the curve being discontinuous, and presenting an angle just below where the clapper strikes, as in the Paris bell. That bell seems to have had a very short life, a large piece having been broken out in a fire the year after it was cast. Sir Roderick Murchison tells me that the sound of the Russian bells is remarkably sweet.

I cannot find that the exact height of a bell makes much difference. The foreign bells, except the Russian ones, it seems, are generally higher than ours, being nearly $\frac{5}{6}$th of their diameter high, whether you measure it vertically inside, or obliquely outside from the lip to the top corner, as the two measures are generally much alike on account of the curvature of the top or *crown*. Ours run from $\frac{2}{3}$rd to $\frac{3}{4}$th of the diameter, though there are some higher; and on the whole my impression is against the high ones. The vertical height inside of all these bells at Westminster is $\frac{17}{24}$ of the diameter. Lower than that, the bell does not look well; and I never saw an ugly bell that was a good one; and it is clear from all our experiments, that the upper or nearly cylindrical part is of considerable importance, and though its vibrations are hardly sensible, it cannot even be reduced in thickness without injury to the sound, of which we had a curious proof. A bell of the usual proportions, in which the thickness of the upper or thin part is one-third of the *sound bow* or thickest part, sounds a third or a fourth above the proper note when it is struck in the waist, and the sound there is generally harsh and unmusical besides. It occurred to both my colleague, the Rev. W. Taylor, and myself, that it would be better to make the waist thinner, so as to give the same note as the sound bow. After two or three trials we succeeded in doing this very nearly, and without reducing the waist below $\frac{1}{4}$th instead of $\frac{1}{3}$rd of the sound bow. The bell sounded very freely with a light blow, and kept the sound a long time, and a blow on the waist gave a much better sound than usual. But for all that, when we tried it at a distance with another bell of the same size and same thickness of sound bow, but a thicker waist, the thin one was manifestly the

16 tons, within 174 lbs., and raised the note from E flat to E. Fortunately the same ratio of increase was made throughout, and the waist is $3\frac{1}{3}$ in., or one-third of the sound-bow, as it ought to be; and therefore the only effect of the mistake is, that the bell is heavier and more powerful; for it being cast the first, the alteration of the note did not signify, as the four quarter bells can as easily be made to accord with E natural as with E flat. And as they will be rather smaller in consequence, the aggregate weight of the whole five will be about 24 tons, as I originally estimated. I have only to add, with reference to this part of the subject, that the width of the bell at the top inside is half the width at the mouth, as it generally is; though in some bells, for instance, the great clock bell at Exeter, it is the outside diameter that is made half the diameter at the mouth. It is of no use to state here the precise geometrical rules by which the pattern of a bell of what we now call the Westminster pattern is drawn, as they are purely empirical. I mean, that having got a bell, by trial, which we all agreed was better than any other, I made out some sufficiently simple rules for drawing the figure of its section by means of a few circles whose radii are all some definite numbers of 24th parts of the diameter of the bell: but there is no kind of *a priori* reason, that I know of, why a bell whose section or *sweep* is made of those particular curves, should be better than any other; and therefore I call the rules for tracing the curve merely empirical; and as they would be of no use to any one but bellfounders, who know them already, or easily may, if they like, I shall say no more on this part of the subject.

As I have been asked many questions about the mode of calculating the size of a bell, so as to produce a particular note, and the answer is very simple, I may as well give it, though it may be found already, with other information on this subject, in the only English book I know of which contains such information, I mean the second edition of my *Lectures on Church Building*, to which a chapter on bells is added. If you make eight bells, of any shape and material, provided they are all of the same, and their sections exactly similar figures (in the mathematical sense of the word), they will sound the eight notes of the diatonic scale, if all their dimensions are in these proportions—60, $53\frac{1}{3}$, 48, 45, 40, 36, 32, 30; which are merely convenient figures for representing, with only one fraction, the inverse proportions of the times of vibration belonging to the eight notes of the scale. And so, if you want to make a bell, a fifth above a given one—for instance, the B bell to our E, it must be $\frac{2}{3}$rd of the size in every dimension, unless you mean to vary the proportion of thickness to diameter; for the same rule then no longer holds, as a thinner bell will give the same note with a less diameter. The reason is, that, according to the general law of vibrating plates or springs, the time of vibration of similar bells varies as $\frac{\text{thickness}}{(\text{diameter})^2}$. When the bells are also completely similar

by Rinmann, in 1784), that it did not answer to make bells of it with the sound-bow thicker than the waist, as usual; and if such bells are worse than the thin ones of that composition, I can only say they must be very bad indeed. I have seen also some cheap bells, evidently composed chiefly of iron, but I do not know what else, and they are much worse than the union metal bells. It is hardly necessary to say much of glass, because its brittleness is enough to disqualify it for use in bells; but besides that, the sound is very weak, compared with a bell-metal bell of the same size, or even the same weight, and of course much smaller.

There is another metal, which you will probably expect me to notice as a desirable ingredient in bells, that is silver. All that I have to say of it is, that it is a purely poetical and not a chemical ingredient of any known bell-metal; and that there is no foundation whatever for the vulgar notion that it was used in old bells, nor the least reason to believe that it would do any good. I happened to hear of an instance where it had been tried by a gentleman who had put his own silver into the pot at the bellfoundry, some years ago. I wrote to him to inquire about it, and he could not say that he remembered any particular effect. This seemed to me quite enough to settle that question. You may easily see for yourselves that a silver cup makes a rather worse bell than a cast-iron saucepan.

Dr. Percy, who has taken great interest in this subject, has cast several other small bells, by way of trying the effect of different alloys, besides the iron and tin just now mentioned. Here is one of iron 95, and antimony 5. The effect is not very different from that of iron and tin of the same proportions, and clearly not so good as copper and tin; and I should mention that antimony is generally considered to produce an analogous effect to tin in alloys, but always to the detriment of the metal in point of tenacity and strength. Again, here is a bell of a very singular composition, copper 88·65, and phosphorus 11·35. It makes a very hard compound, and capable of a fine polish, but more brittle than bell-metal, and inferior in sound even to the iron alloys. Copper 90·14, and aluminium 9·86, which makes the aluminium bear about the same proportion in bulk as the tin usually does, seemed much more promising. The alloy exceeds any bell-metal in strength and toughness, and polishes like gold; and as was mentioned in the lecture here on aluminium last year, it is superior to everything except gold and platinum in its resistance to the tarnishing effects of the air. This alloy would probably be an excellent material for watch wheels, the reeds of organ pipes, and a multitude of other things for which brass is now used—a far weaker and more easily corroded metal, but as yet much cheaper. But for all this, it will not stand for a moment against the old copper and tin alloy for bells; in fact, it is clearly the worst of all that we have yet tried. Here is also a brass

bells is 22 to 7 twice melted; or, reducing it for convenience of comparison to a percentage, the tin is 24·1 of the alloy (not of the copper), and the copper 75·86, which you see is very nearly the same as the result of the analysis of the bell when cast. This may seem extraordinary, because it is well known that the tin wastes more in melting than the copper; but no doubt the explanation of it is, that the antimony which comes out with the tin in the analysis goes in with the copper in the composition, unless special means are taken to eliminate it, which is not worth while, as antimony produces the same kind of effect as the tin, and a little of it does no harm; as we know from intentionally putting some into a small bell, though it is an inferior metal to tin both for bells and organ pipes, in which I understand it is frequently substituted to stiffen the lead, because the English organ builders will not use as much tin as the old ones did, and the German ones still do.

This 22 to 7 mixture, or even 3½ to 1, which is probably the best proportion to use for bells made at one melting, is a much "higher" metal, as they call it, than the modern bellfounders, either English or French, generally use. As there is no great difference in the price of the two metals, the reason why they prefer the lower quantity of tin is, that it makes the bells softer, and therefore easier to cut for tuning, which is obviously a very insufficient reason. I advise everybody who makes a contract for bells, to stipulate that they shall be rejected if they are found on analysis to contain less than 22, or at any rate 21 per cent. of tin, or more than 2 per cent. of anything but copper and tin.

ANALYSIS OF SEVERAL BELL-METALS.

	Rouen.	Gisors.	York.	Lincoln.	Westminster.	
			Old Peal.	1610.	Top.	Bottom.
Copper . . .	71·	72·4	72·76	74·7	75·31	75·07
Tin (with Antimony)	26·	24·2	25·39	23·11	24·37	24·7
Iron	1·2	..	·33	.09	·11	·12
Zinc	1·8	1·	..	traces.	..	..
Lead	..	·4	1·77	1·16	traces	traces
Nickel . . .	..	..	·85	·58	..	..
Specific gravity .			8·76 ..	8·78 ..	8·847 ..	8·869 8·94

The founders were afraid that by insisting on so much tin I should make the bell too brittle. I was satisfied that if they cast it properly it would not be so; and I shall now give some proofs of that. The first is, that the bell has now been rung frequently with a clapper from two to three times as heavy in proportion to the bell as all the other large bells in England, and pulled sometimes by as

weight of the tenor by 2½ cwt.; no doubt judging of its weight according to what a bell of the same size and thickness would be when made of such metal as their new peal was.

This bell is also so elastic, that I can make the clapper of 13 cwt. strike both ways, pulling it alone, and therefore of course to one side only; which I never found the case with any other bell.

You will probably wish to hear something of the actual casting of the bell, which is by no means an easy operation, if we may judge from the much greater rarity of good large bells than of small ones. There was no bell in England above 3 tons weight, except perhaps the tenor of the peal at Exeter, equal to many that exist of half that weight. Sir Christopher Wren condemned and rejected the great bell of St. Paul's, for which the present was substituted in 1716; and that rejected bell was made by a founder whose bells, cast the same year as his St. Paul's bell, are still at St. Alban's, and are very good ones. The present St. Paul's bell is itself inferior to that of Bow and the old York Minster bells; and both the Lincoln and York Minster bells are feeble and unsatisfactory, though the same foundry, until the last 30 or 40 years, turned out many very good bells of smaller but yet considerable weight. The metal was twice melted, as it is for making speculums. It was first run into ingots of bell-metal in a common furnace, and then those ingots were melted and run into the mould from a reverberatory furnace, in which the fuel does not touch the metal, but the flame is carried over and reflected down upon it from the top, or dome over the melting hearth. The ingots were only in this furnace 2½ hours before the metal was ready for running, as the alloy of copper and tin melts, as usual with alloys, at a much lower heat than the most obstinate of the two metals requires alone; and the whole 16 tons were run into the mould in five minutes. I understand that quick casting is essential to the securing of sound casting.

Messrs. Warner make their moulds in a different way from usual. First of all a hollow *core* is built up of bricks, and straw, and clay, and made to fit the inside of the bell by being swept over with a wooden pattern or *sweep*, turning on a vertical axis through the middle of the core. For bells of moderate size, they keep a number of different sized cores of cast iron, instead of building them up of bricks; and the iron cores are covered with the loam as before. They are easily lifted into a furnace to be dried and heated, whereas the brick ones must have the fire lighted within them. But the great difference is in the outside mould, or *cope*. Generally a clay bell is made on the top of the core, the outside being turned by another sweep turning on the same vertical axis; and when this is dry, a third fabric of clay and straw is laid on the outside of the clay bell, and this is called the cope. When it is dry it is lifted off, and the clay bell broken away; the cope is then *put on again*, and the metal poured in where the clay bell was.

method of hanging makes it troublesome and expensive to turn the bell in the stock, to present a new surface to the clapper when it is worn thin in one place, and many bells have been cracked in consequence. A Mr. Baker took out a patent a few years ago for several new modes of hanging, for the purpose of enabling bells to be turned in the stock. The first is simply making a hole in the crown and hanging the bell by a single large bolt, which also spreads out into the staple to carry the clapper. The objection to this is, that nobody would like to trust the weight of a large swinging bell to a single bolt if he could use several instead; because, although a single bolt can of course be made large enough to carry anything, yet if there is any flaw or bad workmanship in it, the result would be something frightful with a large bell; at any rate, nobody who expressed an opinion about it on either of the two occasions when it was exhibited at the Institute of Architects, nor any one whom I have consulted about the making or hanging of the Westminster bells, nor indeed anybody anywhere whose opinion is worth mentioning, so far as I can learn, approves of such a mode of hanging a large bell like this, even though it does not swing, and therefore I declined Mr. Baker's invitation to adopt it. His other method, as described in a recent pamphlet and in his specification, is to cast a thickish pipe on the top of the bell, which is to go through the stock and be fastened with a large nut, just as his iron bolt was in the other plan: only the clapper bolt is now independent and goes through this pipe, and is held by another smaller nut on the top of it. This seems to me to combine the two vices of the weakness of canons and the risk of a single bolt in the most complete manner, with the addition of a thread cut on this bell-metal pipe, which is about as weak a construction as possible. I should think no person in his senses would use such a plan: in fact, Mr. Baker himself did not seem to contemplate using it, but only put it into his patent, as patentees do, with the object of securing possession of every possible new method of doing the thing in question they can think of: but as patentees also do sometimes, he left out at least one method which is better than those which he put in, and that is the following.

On the top of the bell is cast what has been called a button and a mushroom; and either name will do well enough, except that a mushroom has not a hole through it, and buttons have more than one. It is in fact a very thick short neck, with a strong flanch round the top, which is fastened to the stock, in moderate sized bells, merely by bolts with hooked ends; and in very large ones, by bolts passed through a collar, bolted together in two pieces. The clapper (if there is one) is hung by a separate bolt, which goes through the hole in the neck and through the stock; and it has nothing to do with carrying the weight of the bell, unless you like to make it with a shoulder, so as to help the outside bolts. By this method you hang the bell by a lump of its own metal as large as

suppose is much the largest casting in the world. And the other Russian bell, being 18 feet wide, must be 110 tons, according to the Westminster scale, instead of 64, which is the recorded weight. I might have added several other Russian bells to the list, from Lyall's book, all of great weights, but it seemed hardly worth while, as everybody knows already that the Russians have surpassed all the world in the magnitude of their scale of bellfounding, and two or three instances prove as much as twenty. I have stopped the list at four tons. After these would come the single bells of Canterbury, Gloucester, and Beverley Minster, and the tenor bells of the peals of Exeter and York, St. Mary-le-Bow, St. Saviour's, and Sherbourne, which run from 3½ to 2½ tons.

List of Bells.

Bells.	Weight.		Diameter.		Thickness.	Note.	Clapper or Hammer.
	Tons.	Cwt.	Ft.	In.	Inches.		
Moscow, 1736 broken, 1737	250	?	22	8	23	..	..
Another, 1817	110	?	18	0	..	..	1/35 of bell.
Three others	16 to 31		..		..	..	..
Novogorod	31	0	..		..	..	..
Olmutz	17	18	..		..	..	..
Vienna, 1711	17	14	9	10	..	..	..
Westminster, 1856	15	18½	9	5½	9⅜	E.	12 cwt.
Erfurt, 1497	13	15	8	7½	..	F.	..
Paris, 1680	12	16	8	7	7½	..	6½ „
Sens	13	?	8	7	..	..	..
Montreal, 1847	12	15	8	7	8½	F.	..
Cologne, 1448	11	3	7	11	..	G.	..
Breslaw, 1507	11	0	..		..	..	..
Gorlitz	10	17	..		..	..	..
York, 1845	10	15	8	4	8	F sharp.	4 „
Bruges, 1680	10	5	..		..	G.	..
St. Peter's, Rome	8	0	..		..	..	..
Oxford, 1680	7	12	7	0	6⅛	..	80 lbs.
Lucerne, 1636	7	11	..		..	G.	..
Halsberstadt, 1457	7	10	..		..	..	..
Antwerp	7	8	..		..	..	..
Brussels	7	1½	..		..	G sharp.	..
Dantzic, 1453	6	1	..		..	..	..
Lincoln, 1834	5	8	6	10½	6	A.	150 „
St. Paul's, 1716	5	4	6	9	..	A.	180 „
Ghent	4	18	..		..	..	..
Boulogne, new	4	18	..		..	..	..
Exeter, 1675	4	10 ?	6	4	5	A.	75 „
Old Lincoln, 1610	4	8	6	3½	..	B flat.	..
Fourth quarter-bell, Westminster, 1857	4	0	6	0	5¾	B.	..

[E. B. D.]

The following Gentlemen were unanimously elected as Officers for the ensuing year :—

President—The Duke of Northumberland, K.G. F.R.S.
Treasurer—William Pole, Esq. M.A. F.R.S.
Secretary—Rev. John Barlow, M.A. F.R.S.

Managers.

John George Appold, Esq. F.R.S.
Sir Benjamin Collins Brodie, Bart. D.C.L. F.R.S.
Benjamin Bond Cabbell, Esq. F.R.S. F.S.A.
Thomas Davidson, Esq.
Warren De la Rue, Esq. Ph.D. F.R.S.
George Dodd, Esq. F.S.A.
Sir Charles Fellows.
Sir H. Holland, Bt. M.D. F.R.S. F.G.S.
John Carrick Moore, Esq. M.A. F.R.S. F.G.S.
Frederick Pollock, Esq. M.A.
James Rennie, Esq. F.R.S.
Joseph William Thrupp, Esq.
John Webster, M.D. F.R.S.
The Lord Wensleydale.
Charles Wheatstone, Esq. F.R.S.

Visitors.

Beriah Botfield, Esq. M.P. F.R.S. F.S.A.
John Charles Burgoyne, Esq.
John Robert F. Burnett, Esq.
Edmund Beckett Denison, Esq. M.A. Q.C.
Hugh W. Diamond, M.D. F.S.A.
C. Wentworth Dilke, jun. Esq.
Edward M. Foxhall, Esq.
John Hall Gladstone, Esq. Ph.D. F.R.S.
John Hicks, Esq.
Capt. Robert M. Laffan, R.E.
Thomas Lee, Esq.
Rev. Frederic D. Maurice, M.A.
Thomas N. R. Morson, Esq.
Joseph Skey, M.D.
Thomas Young, Esq.

WEEKLY EVENING MEETING,

Friday, May 1.

Rev. J. Barlow, M.A. F.R.S. Vice-President and Secretary, in the Chair.

Captain John Grant, late R.A.

*On the Application of Heat to Domestic Purposes and to Military Cookery.**

The science of heat is more studied, and probably better understood in England than in any other country; but there is a

* The discourse was illustrated by models and diagrams of the cooking apparatus invented and described by Capt. Grant.

GENERAL MONTHLY MEETING,

Monday, May 4.

WILLIAM POLE, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

George Edward Dorington, Esq. and
Arthur Le Noè Walker, Esq.

were duly *elected* Members of the Royal Institution.

William Bowman, Esq. and
Major Lewis Burroughs

were *admitted* Members of the Royal Institution.

The following Professors were unanimously re-elected :—

WILLIAM THOMAS BRANDE, Esq. D.C.L. F.R.S. L. & E., as Honorary Professor of Chemistry in the Royal Institution.

JOHN TYNDALL, Esq. Ph.D. F.R.S. as Professor of Natural Philosophy in the Royal Institution.

The special thanks of the Members were voted to COL. SIR CHARLES HAMILTON, BART. M.R.I. for his present of Bouchette's Map of Lower Canada, in ten sheets.

The following PRESENTS were announced, and the thanks of the Members returned for the same :—

FROM—

Hon. East India Company—Report of Public Instruction in Lower Bengal, for 1855–6. 2 vols. 8vo. 1856.
Asiatic Society of Bengal—Journal, No. 258. 8vo. 1855.
Astronomical Society, Royal—Monthly Notices, Vol. XVII. No. 5. 8vo. 1857.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for April 1857. 8vo.
Boosey, Messrs. (the Publishers)—The Musical World for April 1857. 4to.
British Architects, Royal Institute of—Proceedings in April 1857. 4to.
Cambridge Philosophical Society—Transactions, Vol. IX. Part 4. 4to. 1857.
Chemical Society—Journal, No. 37. 8vo. 1857.

Editors—The Medical Circular for April 1857. 8vo.
The Practical Mechanic's Journal for April 1857. 4to.
The Journal of Gas-Lighting for April 1857. 4to.
The Mechanic's Magazine for April 1857. 8vo.
The Athenæum for April 1857. 4to.
The Engineer for April 1857. fol.
The Artizan for April 1857.
Faraday, Professor, D.C.L. F.R.S. &c.—Königliche Preussischen Akademie. Berichte, 1856, Jan. 1857.
Franklin Institute of Pennsylvania—Journal, Vol. XXXIII. No. 3. 8vo. 1856.
Geographical Society, Royal—Journal. Vol. XXVI. 8vo. 1857.
Geological Survey of India—Memoirs. Vol. I. Part 1. 8vo. Calcutta, 1856.
Graham, George, Esq. (Registrar-General)—Report of the Registrar-General for April 1857. 8vo.
Hamilton, Sir Charles, Bart. C.B. M.R.I.—Map of Lower Canada, in 10 sheets, by Joseph Bouchette.
Map of the Polar Regions, 1825; Chart of Greenland, with the N.W. Voyages of Hudson, Frobisher, and Davis. By A. Arrowsmith, 1825.
Charts of Islands on the Coast of Africa. 1829.
Linnean Society—Journal of Proceedings. No. 4. 8vo. 1857.
Londesborough, The Lord, K.H. F.R.S. M.R.I.—Miscellanea Graphica, Part 12. 4to. 1857.
Newton, Messrs.—London Journal (New Series), April 1857. 8vo.
Novello, Mr. (the Publisher)—The Musical Times, for April 1857. 4to.
Nutt, Mr. D.—Catalogue of Foreign Theological Books. 8vo. 1857.
Pearsall, Mr. Thomas—Catalogues des Bibliothèques du feu Roi Louis Philippe, de M. Tieck, &c. 8vo. 1852–5.
Petermann, A. Esq. (the Author)—Mittheilungen auf dem Gesammtgebiete der Geographie. 1857. Heft 1. 4to. Gotha, 1857.
Photographic Society—Journal, No. 53. 8vo. 1856.
Rammell, T. W. Esq. C.E. (the Author)—A New Plan for Street Railways. 8vo. 1857.
Royal Observatory, Greenwich—Astronomical, Magnetical, and Meteorological Observations in 1855. 4to. 1857.
Royal Society of Literature—Transactions, Vol. IV. and V. 8vo. 1849–56.
Royal Society of London—Proceedings, No. 25. 8vo. 1857.
Society of Arts—Journal for April 1857. 8vo.
Thomas, L. Esq. (the Author)—Rifled Ordnance. 8vo. 1857.
Williams, C. W. Esq. (through Jonathan Green, M.D. M.R.I.)—Prize Essay on the Prevention of the Smoke Nuisance, by C. W. Williams. 8vo. 1856.

WEEKLY EVENING MEETING,

Friday, May 8.

THE LORD WENSLEYDALE, Vice-President, in the Chair.

F. CRACE CALVERT, ESQ. F.C.S. M.R.A. Turin,
HONORARY PROFESSOR OF CHEMISTRY, ROYAL INSTITUTION, MANCHESTER.

On M. Chevreul's Laws of Colour.

MR. CRACE CALVERT stated that he had three objects in view this discourse. The first was to make known the laws of colours, discovered by his learned master, M. Chevreul; secondly, to expl their importance in a scientific point of view; and, thirdly, th value to arts and manufactures.

To understand the laws of colours, it is necessary to know composition of light; Newton was the first person who gave to world any statement relative to the components of light, which said consisted of seven colours—red, orange, yellow, green, bl indigo, and violet. It is now distinctly proved that four of th seven colours of the spectrum are the result of the combinatio of the three colours now known as the primitive colours, viz., r blue, and yellow. Thus blue and red combined produce purple indigo; blue and yellow, green; while red and yellow, produ orange: these facts being known, it is easy to prove that there not seven, but three primitive, and four secondary, called co plementary colours.

Several proofs can be given that light is composed of thr colours only. One of the most simple consists in placing pieces blue, red, and yellow papers on a circular disc, and rotating rapidly; the effect to the eye being to produce a disc of wh light. If, therefore, the eye can be deceived so readily while t disc travels at so slow a rate, what must necessarily be the ca when it is remembered that light proceeds at the rate of 190,0 miles per second?

The rapidity with which light travels is such that the eye is n able to perceive either the blue, red, or yellow, the nerves of t retina not being sensitive enough to receive and convey successive to the mind the three or seven colours of which the light is co posed.

Before entering into the laws of colour, Mr. Crace Calv stated that it might be interesting to know what scientific min had devoted attention to the laws of colours.

The "successive" contrast has long been known; and it consists in the fact that on looking stedfastly for a few minutes on a red surface fixed on a white sheet of paper, and then carrying the eye to another white sheet, there will be perceived on it not a red, but a *green* one; if green, *red;* if purple, *yellow;* if blue, *orange.*

The "simultaneous" contrast is the most interesting and useful to be acquainted with. When two coloured surfaces are in juxtaposition, they mutually influence each other,—favourably, if harmonising colours, or in a contrary manner if discordant; and in such proportion in either case as to be in exact ratio with the quantity of complementary colour which is generated in the eye: for example, if two half-sheets of plain tinted paper, one dark green, the other of a brilliant red, are placed side by side on a grey piece of cloth, the colours will be mutually improved in consequence of the green generated by the red surface adding itself to the green of the juxtaposed surface, thus increasing its intensity, the green in its turn augmenting the beauty of the red. This effect can easily be appreciated if two other pieces of paper of the same colours are placed at a short distance from the corresponding influenced ones, as below:—

Red. Red Green. Green.

It is not sufficient merely to place complementary colours side by side to produce harmony of colour, since the respective intensities have a most decided influence: thus pink and light green agree, red and dark green also; but light green and dark red, pink and dark green, do not; and thus to obtain the maximum of effect and perfect harmony the following colours must be placed side by side, taking into account their exact intensity of shade and tint.

Harmonising Colours.

Primitive Colours.	*Complementary Colours.*		
Red	Green	Light blue Yellow Red	White light.
Blue	Orange	Red Yellow Blue	White light.
Yellow-orange . .	Indigo	Blue Red Yellow	White light.
Greenish Yellow .	Violet	Red Blue Yellow	White light.
Black	White	Yellow Blue Red	White light.

to prevent a grey design acquiring a pinkish shade through working it with green, give the grey a greenish hue, which, by neutralising the pink, will generate white light, and thus preserve the grey.

Mr. Crace Calvert, after explaining the chromatic table of M. Chevreul, which enabled any person at a glance to ascertain what was the complementary colour of any of the 13,480 colours which M. Chevreul had distinctly classed in his table, stated that it was of the highest importance to artists to be acquainted with these laws, in order to know at once the exact colour, shade, and tint, which would produce the greatest effect when placed beside another colour, and that they could save the great length of time which no doubt the great masters lost in ascertaining by experiment those laws, which they could now learn in a few hours by consulting M. Chevreul's work.

[F. C. C.]

WEEKLY EVENING MEETING,

Friday, May 15.

The Lord Wensleydale, Vice-President, in the Chair.

Thomas H. Huxley, F.R.S.

FULLERIAN PROFESSOR OF PHYSIOLOGY ROYAL INSTITUTION.

On the present state of Knowledge as to the Structure and Functions of Nerve.

The speaker commenced by directing the attention of the audience to an index, connected with a little apparatus upon the table, and vibrating backwards and forwards with great regularity. The cause of this motion was the heart of a frog (deprived of sensation though not of life) which had been carefully exposed by opening the pericardium, and into whose apex the point of a needle connected with the index had been thrust. Under these circumstances the heart would go on beating, with perfect regularity and full force, for hours; and as every pulsation caused the index to travel through a certain arc, the effect of any influences brought to bear upon the heart could be made perfectly obvious to every one present.

The frog's heart is a great hollow mass of muscle, consisting of three chambers, a ventricle and two auricles, the latter being separated from one another by a partition or septum. By the successive con-

septum, and entering two other ganglia placed close to the junction of the auricles with the ventricles. From these ganglia nerves are distributed to the muscular substance. Now we know, from evidence afforded by other striped muscles and nerves, that the contraction of the former is the result of the excitement of the latter ; in like manner, we know that the ganglia are centres whence that excitement originates. We are therefore justified, analogically, in seeking for the sources of the contractions of the cardiac muscles, in the cardiac ganglia ; and the experiments which have been detailed—by showing that the rhythmical contractions continue in any part of the heart which remains connected with these ganglia, while it ceases in any part cut off from them—prove that they really are the seats of the regulative power.

The speaker then exhibited another very remarkable experiment (first devised by Weber) which leads indirectly to the same conclusion. An electro-magnetic apparatus was so connected with the frog upon the table, that a series of shocks could be transmitted through the pneumogastric nerves. When this was done, it was seen that the index almost instantly stopped, and remained still, so long as the shocks were continued ; on breaking contact, the heart remained at rest for a little time, then gave a feeble pulsation or two, and then resumed its full action. This experiment could be repeated at will, with invariably the same results; and it was most important to observe, that during the stoppage of the heart the index remained at the lowest point of its arc, a circumstance which, taken together with the distended state of the organ, showed that its stoppage was the result, not of tetanic contraction but of complete relaxation.

Filaments of the pneumogastric nerve can be traced down to the heart, and whenever these fibres are irritated the rhythmical action ceases. The pneumogastric nerves must act either directly upon the muscles of the heart, or indirectly through the ganglia, into which they can be traced. If the former alternative be adopted, then we must conceive the action of the pneumogastric nerve upon muscle to be the reverse of that of all other nerves—for irritation of every other muscular nerve causes activity and not paralysis of the muscle. Not only is this in the highest degree improbable, but it can be demonstrated to be untrue; for on irritating, mechanically, the surface of the heart brought to a standstill by irritation of the pneumogastrics, it at once contracts. The paralysing influence therefore is not exerted on the muscles, and as a consequence, we can only suppose that this "negative innervation," as it might be conveniently termed, is the result of the action of the pneumogastric on the ganglia.

It results from all these experiments, firstly, that nerve substance possesses the power of exciting and co-ordinating muscular actions; and secondly, that one portion of nervous matter is capable of controlling the action of another portion. In the case of the heart it

corpuscles; that, in the spinal cord, the great mass of the grey matter is nothing but connective tissue, the true ganglionic corpuscles being comparatively few, and situated in the anterior horns of the grey substance; finally, it would seem that no ganglionic corpuscle has more than five processes; one, which becomes a sensory fibre and enters the posterior roots of the nerves; one, a motor fibre which enters the anterior roots; one, which passes upward to the brain: one, which crosses over to a ganglionic corpuscle in the other half of the cord; and perhaps one establishing a connexion with a ganglionic corpuscle on the same side.

It is impossible to overrate the value of these discoveries; for if they are truths, the problem of nervous action is limited to these inquiries: *(a)* What are the properties of ganglionic corpuscles? *(b)* What are the properties of their two, or three, commissural processes? For we are already pretty well acquainted with the properties of the sensory and motor processes.

A short account was next given of the physical and physiological phenomena exhibited by active and inactive nerve; and the phenomena exhibited by active nerve were shown to be so peculiar as to justify the application of the title of "nerve force" to this form of material energy.

It was next pointed out that this force must be regarded as of the same order with other physical forces. The beautiful methods by which Helmholtz has determined the velocity (not more than about 80 feet in a second in the frog), with which the nervous force is propagated were explained. It was shown that nerve force is not electricity, but two important facts were cited to prove that the nerve force is a correlate of electricity, in the same sense as heat and magnetism are said to be correlates of that force. These facts were, firstly, the "negative deflection" of Du Bois Raymond, which demonstrates that the activity of nerve affects the electrical relations of its particles; and secondly, the remarkable experiments of Eckhard (some of which the speaker had exhibited in his Fullerian course) which prove that the transmission of a constant currrent along a portion of a motor nerve so alters the molecular state of that nerve as to render it incapable of exciting contraction when irritated.

These facts, even without those equally important though less thoroughly understood experiments of Ludwig and Bernard, which appear to indicate a direct relation between nerve force and chemical change, seem sufficient to prove that nerve force must henceforward take its place among the other physical forces.

This then is the present state of our knowledge of the structure and functions of nerve. We have reason to believe in the existence of a nervous force, which is as much the property of nerve as magnetism is of certain ores of iron; the velocity of that force is measured; its laws are, to a certain extent, elucidated; the structure of the apparatus through which it works promises soon to be

The errors in medical and other works were referred to, especially in regard to the fall of rain, which is nearly double, both in amount and duration, on Dartmoor as compared with the south-eastern coast, from Exmouth to the Start Point, where the humidity of the air is also proportionally less, being, as stated above, the same in *absolute* amount with the average of England, and *sensibly* less in the proportion of 7 to 9. The climate of that coast was shown to be cool and dry in summer, but comparatively humid, as well as warm, in winter, owing to the influence of the sea, which retains a more uniform temperature, exhaling moisture in dry cold weather, but acting as a condenser whenever its temperature is below the dew-point of the air.

A set of instruments were exhibited, which gave, approximately, the following results from one monthly observation :—The maximum and minimum temperature; the maximum, minimum, and mean humidity; the greatest influence, and the duration of sunshine; the amount and duration of rain. The principle of most of these was founded upon the atmometer, with a combination of the wet and dry bulb and differential thermometers. By curves, exhibiting the fluctuations of the barometer, and the character of the weather, was shown how important it was to ascertain also the hygrometrical condition of the atmosphere, the barometer frequently rising before rains from the east. This diagram also proved how little influence the moon exerts, and the fallacy of the generally received opinion that its changes determine the subsequent character of the weather.

In conclusion, a narrative was given of a balloon ascent, illustrated by drawings of aerial phenomena, from sketches taken on the spot. The chief peculiarities of these were, the altitude of the horizon, which remained practically on a level with the eye at an elevation of two miles, causing the surface of the earth to appear concave instead of convex, and to recede during the rapid ascent, whilst the horizon and the balloon seemed to be stationary :—the definite outlines and pure colouring of objects directly beneath, although reduced to microscopic proportions, occasioned by the absence of refraction and dispersion of the coloured rays when passing perpendicularly through media of differing densities, which, at an angle, produce aerial perspective :—the rich combination of rays bursting through clouds, and having the sun's disc for their focus, contrasted with shadows upon the earth which radiate from a vanishing point on the horizon, the narrow shadows of clouds and eminences, such as Harrow and Richmond, being projected several miles, as seen in the lunar mountains: the magnificent Alpine scenery of the upper surfaces of cloud, still illumined, at high altitudes, by the cold silvery ray, contrasted with the rich hues of clouds at lower levels, and the darkness of the earth after sunset.

At higher altitudes than could be attained, and above the level of perpetual congelation, were the beautiful cirrus clouds, com-

The following PRESENTS were announced, and the thanks of the Members returned for the same :—

FROM—

Accademia dei Georgifili, Florence—Degli Studij e delle Vicende Sommario Storico. 8vo. Firenze, 1856.

Accademia Pontificia de' Nuovi Lincei, Roma—Atti, Anno VI. Sessione 1-5. 4to. 1855-6.

Astronomical Society, Royal—Monthly Notices, Vol. XVII. No. 7. 8vo. 1857.

Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for May 1857. 8vo.

Blashfield, J. M. Esq. M R.I.—Selection of Vases, Statues, &c. from Terra-cottas. 4to. 1857.

Boosey, Messrs. (the Publishers)—The Musical World for May 1857. 4to.

British Architects, Royal Institute of—Proceedings in May 1857. 4to.

Busk, Mrs. Wm. (the Author)—Mediæval Popes, Emperors, Kings, and Crusaders. 4 vols. 12mo. 1854.

De la Rue, Warren, Esq. Ph.D. M.R.I.—Saturn as seen through a Newtonian Equatorial, 13 in. aperture, Mar. 27, 1856.

Jupiter, as seen, Oct. 25, 1856.

Dilettanti, Society of—Historical Notices of the Society of Dilettanti. 4to. 1855.

Editors—The Medical Circular for May 1857. 8vo.

The Practical Mechanic's Journal for May 1857. 4to.

The Journal of Gas-Lighting for May 1857. 4to.

The Mechanic's Magazine for May 1857. 8vo.

The Athenæum for May, 1857. 4to.

The Engineer for May, 1857. fol.

The Artisan for May 1857.

Faraday, Professor, D.C.L. F.R.S. &c.—Königliche Preussischen Akademie —Berichte, 1856, Feb. 1857.

Forrester, the Baron, M.R.I. (the Author)—Memoria sobre o Curativo da Molestia nas Videiras [and other Papers]. 8vo. Porto, 1857.

Geographical Society, Royal—Journal. Vol. XXVI. 8vo. 1857.

Geological Survey of India—Memoirs. Vol. I. Part 1. 8vo. Calcutta, 1856.

Graham, George, Esq. (Registrar-General)—Reports of the Registrar-General for May 1857. 8vo.

Holland, Sir Henry, Bart. M.D. F.R.S. M.R.I.—Army Meteorological Registry from 1843 to 1854. 4to. Washington, U.S., 1855.

Annals of the Astronomical Observatory of Harvard College, U.S. Vol. I. Part 1. 4to. 1856.

Hope, A. J. Beresford, Esq. M.P. (the Author)—Public Offices and Metropolitan Improvements. 8vo. 1857.

Kaiserliche Geologische Reichsanstalt, Wien, (through M. W. Haidinger)—Abhandlungen, Band 1-3. 4to. 1852-6.

Jahrbuch, 1-7. 8vo. 1852-56.

Uebersicht der Resultate Mineralogischer Forschungen von Dr. G. A. Kenngott. 3 Bande. 1844-52. 4to. 1852-4.

Katalog der Bibliothek des K. K. Hof-Mineralien Cabinets in Wien, von P. Partsch. 4to. 1851.

Naturwissenschaftliche Abhandlungen, gesammelt und herausgegeben von W. Haidinger. Vol. 1-4. 4to. 1847-51.

Berichte herausgegeben von W. Haidinger. Bande 1-7. 8vo. 1847-51.

Kerr, Mrs. Alexander, M.R.I.—La Normandie Souterraine, par l'Abbé Cochet. 8vo. Paris, 1855.

Sepultures Gauloises, Romaines, Franques, et Normandes, par l'Abbé Cochet. 8vo. Paris, 1857.

Newton, Messrs.—London Journal (New Series), May 1857. 8vo.

Nicholson, Rev. Dr. H. J. (the Author)—The Abbey of St. Alban. 8vo. 1857.

his experiments before the Société d'Encouragement, and more recently before the Emperor of the French. When he became acquainted with the speaker's intention to introduce these experiments at the Royal Institution, he in the most obliging manner offered to come to London and make them himself. This offer was accepted, and the speaker also congratulated the audience on the presence of M. Duboscq, who took charge of his own electric lamp; this being the source of light made use of on the occasion.

The experiments proceeded in the following order:—

1. A sheaf of light was thrown from the lamp upon a mirror held in the speaker's hand: on moving the mirror with sufficient speed the beam described a luminous ring upon the ceiling. The persistance of impressions upon the retina was thus illustrated.

2. A tuning fork had a pointed bit of copper foil attached to one of its prongs: the fork being caused to vibrate by a violin bow the metallic point moved to and fro, and being caused to press gently upon a surface of glass coated with lamp black, the fork being held still, a fine line of a length equal to the amplitude of the vibrations was described upon the glass; but when at the same time the whole fork was drawn backwards with sufficient speed, a sinuous line was described upon the glass. The experiment was made by placing the coated glass before the lamp; having a lens in front of it, and bringing the surface of the glass to a focus on a distant screen. On drawing the fork over the surface in the manner described, the figure started forth with great beauty and precision. By causing a number of forks to pass at the same time over the coated glass, the relations of their vibrations were determined by merely counting the sinuosities. The octave, for example, had double the number of its fundamental note.

3. This was the first of the series of M. Lissajous' experiments. A tuning fork, with a metallic mirror attached to one of its prongs, was placed in front of the lamp; an intense beam of light was thrown on the mirror, and reflected back by the latter. This reflected beam was received on a small looking-glass, held in the hand of the experimenter, from which it was reflected back upon the screen. A lens being placed between the lamp and tuning fork, a sharply defined image of the orifice from which the light issued was obtained. When a violin bow was drawn across the fork, this image elongated itself to a line. By turning the mirror in the hand, the image upon the screen was resolved into a bright sinuous track, many feet in length.

4. A tuning fork was placed before the lamp, as in the last experiment. But instead of receiving the beam reflected from the mirror of the fork upon a looking-glass, it was received upon the mirror of a second fork, and reflected by the latter upon the screen. When one fork was excited by a bow, a straight line described itself upon the screen, when the other fork was subsequently excited, the figure described was that due to the combination of the vibra-

WEEKLY EVENING MEETING,

Friday, June 12.

Sir Benjamin Collins Brodie, Bart. D.C.L. F.R.S. Vice-President, in the Chair.

Professor Faraday, D.C.L. F.R.S.

On the Relations of Gold to Light.

This subject was brought forward on the 13th of June of last year, and in the account of that evening, at page 310, vol. ii. of the Proceedings of the Royal Institution, will be found a description of some of the proofs and effects then referred to and illustrated; the following additional remarks will complete the account up to this time. The general relations of *gold leaf* to light were described in the former report. Since then, pure gold leaf has been obtained through the kindness of Mr. Smirke, and the former observations verified. This was the more important in regard to the effect of heat in taking away the green colour of the transmitted light, and destroying to a large extent the power of reflexion. The temperature of boiling oil, if continued long enough, is sufficient for this effect; but a higher temperature (far short of fusion) produces it more rapidly. Whether it is the result of a mere breaking up by retraction of a corrugated film, or an allotropic change, is uncertain. Pressure restores the green colour; but it also has the like effect upon films obtained by other processes than beating. Corresponding results are produced with other metals.

As before stated, *films* of gold may be obtained on a weak solution of the metal, by bringing an atmosphere containing vapours of phosphorus into contact with it. They are produced also when small particles of phosphorus are placed floating on such a solution; and then, as a film differing in thickness is formed, the concentric rings due to Newton's thin plates are produced. These films transmit light of various colours. When heated they become amethystine or ruby; and then when pressed, become green, just as heated gold leaf. This effect of pressure is characteristic of metallic gold, whether it is in leaf, or film, or dust.

Gold wire, separated into very fine particles by the electric *deflagration*, produces a deposit on glass, which, being examined, either chemically or physically, proves to be pure metallic gold.

British Architects, Royal Institute of—Proceedings in July 1857. 4to.
British Association—Report of the Twenty-sixth Meeting, held at Cheltenham, 1856. 8vo. 1857.
Burel, M. E.—Rapport sur l'Exposition Universelle de 1855. 8vo. Rouen, 1856.
Canada, Government of—Catalogue of the Library of the Parliament of Canada. 8vo. 1857.
Chemical Society—Journal, No. 39. 8vo. 1857.
Daubeny, Charles, M.D. F.R.S. (the Author)—Lectures on Roman Husbandry. 8vo. 1857.
Denison, E. Beckett, Esq. M.A. Q.C. M.R.I. (the Author.)—Clocks and Locks. 16to. 1857.
Two Lectures on Gothic Architecture. By G. G. Scott and E. B. Denison. 12mo. 1857.
Department of State, Washington, U.S.—Track Survey of the Rivers Paraña, Uruguay, &c. By Capt. Thos. Page. 1855.
Dublin Geological Society—Journal, Vol. VII. No. 4. 8vo. 1857.
Dublin Society, Royal—Journal, No. 6. 8vo. 1857.
Editors—The Medical Circular for July to Oct. 1857. 8vo.
The Practical Mechanic's Journal for July to Oct. 1857. 4to.
The Journal of Gas-Lighting for July to Oct. 1857. 4to.
The Mechanic's Magazine for July to Oct. 1857. 8vo.
The Athenæum for July to Oct. 1857. 4to.
The Engineer for July to Oct. 1857. fol.
The Artisan for July to Oct. 1857.
Faraday, Professor, D.C.L. F.R.S. &c. (the Author)—On the Relations of Gold to Light. (Phil. Trans.) 4to. 1857.
Königliche Preussischen Akademie, Berichte, Mai—Aug. 1857.
Oversigt over det Kongelige Danske Videnskabernes Selskab, Fordhandlinger, 1856. 8vo. 1856.
Tageblatt der 32te Versammlung Deutscher Naturforscher in Wien in 1856. 4to. 1857.
Memorie della Reale Accademia delle Scienze, Napoli, dal 1852. Vol. I. Fasc. 1 & 2. 4to. 1856-7.
Rendiconto della Società Reale Borbonica. Anno V. 1856. Bimestre Gennaio e Febbraio. 4to.
Akademie der Wissenschaften, Wien: Math. Nat. Classe: Denkschriften, Band XII. 4to.; Sitzungsberichte. Band XX., XXI, XXII., und XXIII. Heft I., und Register zu Band XI.-XX. 8vo. 1856-7.
Almanach, 1857. 12to.
Accademia de Belgique: Bulletins de la Classe des Sciences, 1855-56. 8vo. Bruxelles, 4to. 1856-57.
Academie di Torino; Memorie, Serie Seconda. Tomo XVI. 4to. 1857.
Società Italiana in Modena; Memorie, Tomo XXV. Parte 2. 4to. 1855.
M. Quetelet: Observations des Phénomènes Périodiques. 4to. 1857: Sur le Climat de la Belgique. 4to. Bruxelles, 1857.
Meteorological Papers, published by Authority of the Board of Trade. No. I. 4to. 1857.
Franklin Institute of Pennsylvania—Journal, Vol. XXXIII. No. 6; Vol. XXXIV. No. 1. 8vo. 1857.
Gellibrand, W. Esq.—Vocabulary of the Aborigines of Tasmania. By Joseph Milligan. fol. 1857.
Geographical Society, Royal—Proceedings. Nos. 9, 10. 8vo. 1857.
Geological Society—Journal, No. 51. 8vo. 1857.
Glasgow Philosophical Society—Constitution of the Society; and the Catalogue of the Library. 8vo. 1850-7.
Graham, George, Esq. (Registrar-General)—Reports of the Registrar-General for July to Oct. 1857. 8vo.
Graubündens Naturforschende Gesellschaft—Jahresberichte. Neue Folge I. und II. 8vo. 1854-6.

GENERAL MONTHLY MEETING,

Monday, December 7.

WILLIAM POLE, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

Charles Brooke, Esq. F.R.S.

was duly *elected* a Member of the Royal Institution.

Neil Arnott, M.D. F.R.S.

was *admitted* a Member of the Royal Institution.

The Secretary reported that the following Arrangements had been made for the Lectures before Easter, 1858:—

Six Lectures on STATIC ELECTRICITY (adapted to a Juvenile Auditory), by MICHAEL FARADAY, Esq. D.C.L. F.R.S. &c. Fullerian Professor of Chemistry, R.I.

Twelve Lectures on the PRINCIPLES OF BIOLOGY, by THOMAS HENRY HUXLEY, Esq. F.R.S. Fullerian Professor of Physiology, R.I.

Ten Lectures on HEAT, CONSIDERED AS A MODE OF MOTION, by JOHN TYNDALL, Esq. F.R.S. Professor of Natural Philosophy, R.I.

Ten Lectures on the CHEMISTRY OF THE ELEMENTS WHICH CIRCULATE IN NATURE, by CHARLES L. BLOXAM, Esq. Professor of Practical Chemistry, King's College, London.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM—

Hon. East India Company—Bombay Magnetical and Meteorological Observations for 1854 and 1855. 4to.

American Academy of Sciences—Proceedings, Vol. III. Nos. 24-31. 8vo. 1856.

Memoirs, New Series, Vol. VI. Part 1. 4to. 1857.

American Philosophical Society—Proceedings, No. 56. 8vo. 1857.

Astronomical Society, Royal—Monthly Notices, Vol. XVII. No. 9. 8vo. 1857.

Athenæum Club—List of Members, &c. 16to. 1857.

Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for Nov. 1857. 8vo.

Boosey, Messrs. (the Publishers)—The Musical World for Nov. 1857. 4to.

Boston Society of Natural History—Proceedings, Vol. V. Nos. 21-26. Vol. IV. Nos. 1-10. 8vo. 1856-7.

Rennie, James, Esq. F.R.S. M.R.I.—Mathematical Treatises. By the Rev. J. West. 8vo. 1838.
Elements of Christian Theology. By Bishop Pretyman [Tomline]. 2 vols. 8vo. 1799.
Traité de Trigonométrie, par S. F. Lacroix. 8vo. Paris, 1837.
Précis de Géométrie, par A. J. Vincent. 8vo. Paris, 1837.
Traité de Géométrie Descriptive, par L. Lefébure de Fourcy. 8vo. Paris, 1837.
Royal College of Surgeons—Catalogue of the Library. 5 vols. 8vo. 1840-55.
Roma, Accademia Pontificia de' Nuovi Lincei—Atti, Anno VII. Sess. 1, 2. Anno. X. Sess. 1-5. 4to. 1856-7.
Sächsische Gesellschaft der Wissenschaften—Abhandlungen, Band VI. Hefte 1 und 2. 4to. 1857.
Berichte, 1856, Hefte 2. 1857, Hefte 1. 8vo.
Shaw, Alexander, Esq. M.R.I.– Report on Dr. Fell's Treatment of Cancerous Diseases at Middlesex Hospital. 8vo. 1857.
Smithsonian Institution, Washington—Tenth and Eleventh Annual Reports. 8vo. 1856-7.
Smithsonian Contributions, Vol. IX. 4to. 1857.
Researches on the Ammonio-Cobalt Bases; by W. Gibbs and S. Genth. 4to. 1856.
Society of Arts—Journal for Nov. 1857. 8vo.
Sopwith, Thos. Esq. M.R.I. (the Author)—Notes of a Visit to Egypt. 16to. 1857.
Streatfeild, J. F. Esq. (the Editor)—Ophthalmic Hospital Reports. No. 1. 8vo. 1857.
United States Coast Survey—Report for 1855.
Zoological Society—Proceedings, Nos. 334-338. 8vo. 1857.

1858.

WEEKLY EVENING MEETING,

Friday, January 22.

WILLIAM POLE, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

PROFESSOR J. TYNDALL, F.R.S.

On some Physical Properties of Ice.

THE discourse was prefaced by some remarks on force in general; and more especial attention was afterwards directed to the force, or application of force, manifested in the phenomena of crystallization. Experimental illustrations were exhibited, and the speaker passed on to the particular case of crystallized water, or ice. Being

tion, because the volume of the liquid is less than that of the ice which produced it; whereas, if the air be simply that entrapped in the snow of the névé, it will not be thus rarefied. Here, then, we have a test as to whether the water-cells have been produced by the melting of the ice.

Portions of ice containing these compound cells were immersed in hot water, the ice around the cavities being thus gradually melted away. When a liquid connexion was established between the bubble and the atmosphere, the former collapsed to a smaller bubble. In many cases the residual bubble did not reach the hundredth part of the magnitude of the primitive one. There was no exception to this rule, and it proves that the water of the cavities is really due to the melting of the adjacent ice.

The first hypothesis above referred to is that of M. Agassiz; which has been reproduced and subscribed to by the Messrs. Schlagintweit, and accepted generally as the true one. Let us pursue it to its consequences.

Comparing equal *weights* of air and water, experiment proves that to raise a given weight of water one degree in temperature, as much heat would be needed as would raise the same weight of air four degrees.

Comparing equal *volumes* of air and water, the water is known to be 770 times heavier than the air; consequently, for a given *volume* of air to raise an equal *volume* of water one degree in temperature, it must part with $770 \times 4 = 3080$ degrees.

Now the quantity of heat necessary to melt a given weight of ice would raise the same weight of water 142·6 Fahr. degrees in temperature. Hence to produce, by the melting of ice, an amount of water equal to itself in bulk, a bubble of air must yield up $3080 \times 142 \cdot 6$, or upwards of four hundred thousand degrees Fahrenheit.

This is the amount of heat which, according to the hypothesis of M. Agassiz and the Messrs. Schlagintweit, is absorbed by the bubble of the air in a short time under the eyes of the observer. That is to say, the air is capable of absorbing an amount of heat which, had it not been communicated to the surrounding ice, would raise the bubble to a temperature 160 times that of fused cast iron. Did air possess this enormous power of absorption it would not be without inconvenience for the animal and vegetable life of our planet.

The fact is, that a bubble of air at the earth's surface is unable, in the sightest appreciable degree, to absorb the sun's rays; for those rays before they reach the earth have been perfectly sifted by their passage through the atmosphere. The following experiment illustrative of this point, has been made by the speaker: the rays from an electric lamp were condensed by a lens, and the concentrated beam sent through the bulb of a differential thermometer. The heat of the beam was intense; still not the slightest effect was

WEEKLY EVENING MEETING,

Friday, January 29.

Sir Benjamin Collins Brodie, Bart., D.C.L. F.R.S.
Vice-President, in the Chair.

William Robert Grove, Esq. Q.C. V.P.R.S.

On Molecular Impressions by Light and Electricity.

The term *molecule* is used in different senses by different authors: by some it is employed with the same meaning as the word *atom*, *i.e.*, to signify an ultimate indivisible particle of matter; by others to signify a definite congeries of atoms forming an integral element of matter, somewhat as a brick may be said to be a congeries of particles of sand, but a structural element of a house.

The term is used this evening to signify the particles of bodies smaller than those having a sensible magnitude, or only as a term of contradistinction from masses. If there be any distinctive characteristic of the science of the present century as contrasted with that of former times, it is the progress made in molecular physics, or the successive discoveries which have shown that when ordinary ponderable matter is subjected to the action of what were formerly called the imponderables, the matter is molecularly changed. The remarkable relations existing between the physical structure of matter, and its effect upon heat, light, electricity, magnetism, &c., seems, until the present century, to have attracted little attention: thus, to take the two agents selected for this evening's discourse, Light and Electricity, how manifestly their effects depend upon the molecular structure of the bodies subjected to their influence? Carbon in the form of diamond transmits light but stops electricity. Carbon in the form of coke or graphite, into which the diamond may be transformed by heat, transmits electricity but stops light. All solid bodies which transmit light freely, or are transparent, are non-conductors of electricity, or may be said to be opaque to it; all the best conductors of electricity, as black carbon and the metals, are opaque or non-conductors of light.* Bodies which have a peculiar but definite and symmetrical structure, such as crystals, affect light definitely and in strict relation to their structure: witness the effects of polarized light on crystals; and there are not wanting instances

* It should be borne in mind that these terms are not absolute, but only express a high degree of approximation.

phosphorescent force, and produce a circular mark on the photographic paper, and even impress on the latter the lines of an engraving interposed between it and the photographic surface.

Phosphorescent bodies produce similar effects in a greater degree, and bodies which intercept the phosphorescent effect intercept the invisible radiations. A design drawn by a fluorescent substance, such as a solution of sulphate of quinine on paper, is reproduced, the design being more strongly impressed than the residual parts of the paper.

Mr. Grove had little doubt that had the discourse been given in the summer instead of mid-winter, he could have literally realised in this theatre the Lagado problem of extracting sunbeams from cucumbers!

While fishing in the autumn, in the grounds of M. Seguin, at Fontenay, Mr. Grove observed some white patches on the skin of a trout, which he was satisfied had not been there when the fish was taken out of the water. The fish having been rolling about in some leaves at the foot of a tree, gave him the notion that the effect might be photographic, arising from the sunlight having darkened the uncovered, but not the covered portions of the skin. With a fresh fish a serrated leaf was placed on each side, and the fish laid down so that the one side should be exposed, the other sheltered from light: after an hour or so the fish was examined, and a well defined image of the leaf was apparent on the upper or exposed side, but none on the under or sheltered side. There was no opportunity of further experiment; but there seems little doubt of the effect being photographic, or an oxidation or deoxidation of the tissue determined by light.

Many important considerations might be suggested as deducible from the above results, as to the influence of light on health, both that of vegetables and animals. The effect of light on the healthy growth of plants is well known; and it is generally believed that dark rooms, though well heated and ventilated, are more "close" or less healthy than those exposed to light. When we consider the invisible phosphorescence which must radiate from the walls and furniture, when we consider the effects of light on animal tissue, and the probable ozonizing or other minute chemical changes in the atmosphere effected by light, it becomes probable that it is far more immediately influential on the health of the animate world than is generally believed.

The number of substances proved to be molecularly affected by light is so rapidly increasing, that it is by no means unreasonable to suppose that all bodies are in a greater or less degree changed by its impact.

Passing now to the effects of Electricity, every day brings us fresh evidence of the molecular changes effected by this agent. The electric discharge alters the constitution of many gases across which it is passed; and it was shown, that by passing it through

these, retaining its polish. The molecular change is extremely delicate, and can only be seen in certain inclinations to the light; it does not seem to affect the performance of the glass. Dollond died in 1761; but whether made by him or his son, the instrument bears internal evidence of being very old; and was represented as having been 40 years in the shop where it was bought. We have therefore an experiment of very long duration, and which presents these remarkable points: 1st, There is a notable distance between the radiating surfaces. 2ndly, The impression is permanently etched, and not capable of being removed by any cleaning of the surface. It would be out of place in this note to enter on the theory of this effect.

[W. R. G.]

GENERAL MONTHLY MEETING,

Monday, February 1.

WILLIAM POLE, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

Richard Corbet, Esq.
Roger Fenton, Esq.
Mervyn Hamilton, Esq.
William Augustus Hillman, Esq. F.R.C.S. and
John Leighton, jun. Esq. F.S.A.

were duly *elected* Members of the Royal Institution.

Charles Brooke, Esq. F.R.S.

was *admitted* a Member of the Royal Institution.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM—
Actuaries, Institute of—Assurance Magazine. No. 30. 8vo. 1857.
Anonymous—Neufchâtel, and its Events since 1814. 8vo. 1857.
Asiatic Society of Bengal—Journal, No. 263. 8vo. 1857.
Astronomical Society, Royal—Monthly Notice, Dec. 1857.
Basel Naturforschende Gesellschaft—Verhandlungen, Viertes Heft. 8vo. 1857.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for Jan. 1858. 8vo.
Boosey, Messrs. (the Publishers)—The Musical World for Jan. 1858. 4to.
Bombay Geographical Society—Transactions, Vol. XIII. 8vo. 1857.

Society of Arts—Journal for Nov. and Dec. 1857, and Jan. 1858. 8vo.
Sopwith, Thomas, Esq. F.R.S. M.R.I. (*the Author*)—Reminiscences of First Visits to Scotland, London, and the South-West of England in 1828, 1830, and 1833. 16to. 1847.
Treatise on Isometrical Drawing. 2nd Edition. 8vo. 1838.
Taylor, Rev. W. F.R.S.—Portraits. 16to. Leipzig, 1779.
Vereins zur Beförderung des Gewerbfleisses in Preussen—Sept. and Oct. 1857. 4to.
Von Kersten, Charles, Esq. (*the Author*)—Reading made Easy (for German, English, and French, by New Characters.) 8vo. Brussels, 1857.
Wilson, Thomas, Esq. M.R.I.—Plans of the Lake of Haarlem and its Drying-up. 1843-55.
Yearsley, James, Esq. M.R.I. (*the Author*)—Controversy on the Artificial Tympanum. 8vo. 1858.
Zoological Society of London—Proceedings, Nos. 334-338. 8vo. 1857.

WEEKLY EVENING MEETING,

Friday, February 5.

The Lord Wensleydale, Vice-President, in the Chair.

Edwin Lankester, M.D. F.R.S. M.R.I.

On the Drinking Waters of the Metropolis.

In bringing the subject of the drinking waters of the metropolis before his audience, the lecturer stated that he wished to address them not as a chemist or a naturalist, but as a medical officer of health. He wished to make his lecture practical, and to answer the question, What water shall we drink? Water might be discoursed on as a solid, a liquid, or a vapour, and from every point of view it had deep interest for man. It was as one of the great factors of the organic kingdoms, that he must now regard it. Water was necessary to the formation of the tissues of both plants and animals. Some water plants consisted of from 90 to 95 per cent. of water, whilst Professor Owen had estimated the solid matter of a jelly-fish weighing two pounds, at sixteen grains. Seventy-eight parts in the hundred of blood, and seventy-two parts in the hundred of muscle was water. Most kinds of solid human food contained more than fifty per cent. of water.

Water was not only necessary to the formation of animal and vegetable tissues, but to the introduction into the system of *saline* and *organic* matters. The water of the blood held 420 grains of saline matters in solution, and the tissues also contained salts, such as phosphate of lime, which were introduced by the agency of water. The organised matters of the food of animals were taken

The spring-curtain of this lock may be adapted to almost any other, and is particularly recommended for street-door or "latch" locks, as they are called, which are very liable in such towns as London to be spoiled, or put out of order, by the action of the air and dirt upon them. Mr. Hobbs adds this curtain to his latch locks for a trifling extra charge, the cost of making it being insignificant; and it supersedes the necessity for an external "scutcheon" on the key-hole, which seldom keeps long in action, and is not so effectual as this self-acting curtain.

Mr. Denison also exhibited three small bells, made by Mr. Mears: one of the same metal as the great bell of Westminster which he is now re-casting; another, with the addition of as much silver as would amount to 1 cwt. and cost £500 in a 16-ton bell; and the third with rather more. These bells clearly bore out the statement made in the lecture on bells last year, that the tone would not be improved by adding silver, of which also no trace has been found in any old bell-metal that has been analyzed.

[E. B. D.]

WEEKLY EVENING MEETING,

Friday, February 26.

The Lord Wensleydale, Vice-President, in the Chair.

Rev. Baden Powell, M.A. F.R.S. F.G.S. F.R.A.S.

SAVILIAN PROF. OF GEOMETRY, OXFORD.

On Rotatory Stability; and its Applications to Astronomical Observations on board Ships.

The subject of rotatory motion, especially when taking place under those combinations which are presented in the gyroscope, or free balanced revolver, has attracted much attention at the present day; and though the primary mechanical principles bearing upon it had been long since understood and acknowledged in *theory*, yet the practical results to which they might lead had been so little considered, that when first tangibly exhibited they excited unbounded surprise.

Even some scientific persons were at a loss to account for them, or sceptical as to their real nature; especially when they witnessed the wonderful results obtained by M. Foucault, apparently subverting the laws of equilibrium, and looking more like magic or legerdemain than sober philosophical experiments. Yet while

The principle of fixity of the plane of rotation had been universally recognised in theory; and it could not have been doubted that in proportion to the momentum acquired by giving immense velocity to the rotating mass, this constancy would be more vigorously displayed; yet perhaps few were prepared for the actual result as exhibited by M. Foucault: even when the principle was acknowledged, nothing could seem more astonishing than the obstinate resistance of the disk to any inclination from its original plane of rotation; which no ordinary degree of force would overcome. This principle is that chiefly referred to in the inventions about to be described, where the effect depends essentially on the great amount of resistance thus offered to any angular motion impressed by an extraneous cause on a perfectly balanced revolving heavy disk.

When we consider the vast amount of precautions taken by astronomers for securing the *stability* of their instruments, and the careful plans adopted for guarding against every imaginable cause of disturbance on land, it may seem surprising that even any attempt should be made to carry on such operations at sea. Yet it is a matter of necessity: some observations must be made for determining the place of the ship, on which its safety depends; and other cases often occur when phenomena of great value to astronomy,—the science without which the ship could not be navigated,—are required to be observed at sea; or may perhaps only be visible at positions out on the ocean. The most important of these observations are those of the *altitudes* of the heavenly bodies, on which depends both the determination of the *latitude*, and the correction of *time* essential to finding the *longitude;* and for this purpose there is a necessity for a well defined horizon, which it is often impossible to obtain from the state of the atmosphere in its lower parts, though the sun or star can be distinctly seen above, and this more especially at night; yet the safety of the ship may essentially depend on such an observation.

Hence various plans have been resorted to for obtaining an *artificial* horizon. Simple reflection from the surface of a liquid can hardly ever be practicable, on account of the motion of the ship, though it is the usual substitute on land; by the reflected image, seen as much below the true horizon as the object is above it.

The most celebrated attempt to substitute some other principle, was an application of *rotatory motion*, devised by the late Mr. Troughton, in 1820. It consists in causing a disk, truly balanced on a fixed pivot, to spin round with great velocity, so as to keep up its motion during the time required for an observation, known by the name of "Troughton's top." The disk carries a plane reflector on its upper surface; and being a cylinder hollowed out at its lower end, and the point of support within, the centre of gravity is thrown below, so that it is in stable equilibrium when at rest. The

of the earth; and when restricted to one plane it acts as a magnetic needle without magnetism, or spontaneously rotates in parallelism with the earth. To these remarkable, diversified, and somewhat paradoxical applications, we have now added another of far higher utility, that it gives perfect stability for the nicest astronomical observations on board a ship, pitching and tossing with every wave and gust of wind.

[Besides models, illustrative of the principle, the actual instruments were exhibited by Prof. C. P. Smyth.]

[B. P.]

GENERAL MONTHLY MEETING,

Monday, March 1.

William Pole, Esq. M.A. F.R.S. Treasurer and Vice-President, in the Chair.

Edward Levi Ames, M.A.
Herbert Barnard, Esq.
George Bishop, jun., Esq.
John Ashton Bostock, Esq.
S. M. Boulderson, Esq.
Edward Hay Currie, Esq.
William Day, Esq.
Alfred Hamilton, Esq.
Joseph Haynes, Esq.
Stanley Haynes, Esq.
Alfred Gutteres Henriques, Esq.
Thomas Hyde Hills, Esq.
William Longman, Esq.
Mrs. Lyon Playfair.
Sir James P. Kay Shuttleworth, Bart.
William Southey, jun., Esq.
William T. H. Strange, Esq.
Robert Tait, Esq.
Matthew Uzielli, Esq.

were duly *elected* Members of the Royal Institution.

William Augustus Hillman, Esq. F.R.C.S.
John Leighton, jun. Esq. F.S.A.

were *admitted* Members of the Royal Institution.

The Secretary announced that the following Arrangements had been made for the Lectures after Easter:—

Nine Lectures on the History of Italy during the Middle Ages, by James Philip Lacaita, Esq. LL.D.

Three Lectures (*in continuation*) on Heat, considered as a Mode of Motion, by John Tyndall, Esq. F.R.S. Professor of Natural Philosophy, R.I.

Saumarez, Rear-Admiral (the Author)—Introductory Key to the Hieroglyphic Phraseology of the Old Testament. 4to. 1858.
Society of Arts—Journal for Feb. 1858. 8vo.
Taylor, Rev. W. F.R.S. M.R.I.—Specimen of the Great Bell of Westminster ["Big Ben"] now being broken up.
Thomson, Professor W.—Specimen of the Shore-end of the Atlantic Telegraph Wire.
Vereins zur Beförderung der Gewerbfleisses in Preussen—Nov. und Dec. 1857. 4to.
Window, F. R. Esq. (the Author)—On Submarine Electric Telegraphs. 8vo. 1857.

Professor Faraday, *on Static Induction.*

(Addition to the Report of the 12th of February.)

The inquiries made by some who wish to understand the real force of the test experiments relating to static induction, brought forward on the above date (page 470,) and their consequences in relation to the theory of induction, make me aware that it is necessary to mention certain precautions which I concluded would occur to all interested in the matter: I hope the notice I propose to give here will be sufficient. When metallic coatings or carriers are employed for the purpose of obtaining a knowledge of the state of a layer of insulating particles, as those forming the surface of a plate of sulphur, it is very necessary that they should exist in a plane perpendicular to the lines of the inductive force, and in a field of action where the lines of force are *sensibly equal.* Hence the importance of the dimensions given in the description of the apparatus at page 472 of the report of the evening, when the inductive surfaces are described as 9 inches in diameter, and 9 inches apart. The inductive surface there mentioned is a plane: a ball cannot properly be used for this purpose; for the lines of inductive force originating at it cannot then be perpendicular to the layer of gold-leaf forming the coating of the sulphur. The consequence would be that this layer of gold being virtually extended along the lines of inductive force, *i.e.* having parts nearer to and parts more distant from the inductric, will be polarized according to well-known electrical actions, will have opposite states at those parts, will show these states by a carrier, and will give results not belonging merely to insulating particles in a section across the lines, but chiefly to united conducting particles in a section oblique to or along the lines.

The carrier itself must be perfectly insulated the whole time, or else a case of induction, not including the sulphur, and entirely different to that set out with is established. It must not even *extend* by elongation into parts of the field of induction where the

force differs in degree; or else errors of the same kind as those described with the ball inductric will occur. It should also be so used as to receive no charge by convection. When introduced between the inductric and the sulphur, it is very apt, if the charge be high, or if particles adhere to the inductric, to receive a charge. This is easily tested by introducing the carrier into its place, abstaining from touching the gold-leaf, withdrawing the carrier, and examining it: it is not until this can be done without bringing away any charge that the carrier should be employed to touch the gold-leaf surface, and bring away the indication of its electrical state.

As before said, if when the state of matters is perfect, and no convection interferes, the gilt sulphur be put into its place, left there for a short time, and brought away again, it will be found without *any* charge either of the gold-leaf coating or the sulphur. If it be put into place, the coating next the inductric be uninsulated for a moment only, and the plate brought away, that coating will then appear positive. If it be put into place and the further gold-leaf be uninsulated for a moment, that coating when the plate is brought away will be found negative. These are all well known results, and will always appear if convection and other sources of error be avoided.

22nd March, 1858. M. F.

extemporizes, as it were, a stomach for itself in the substance of its body, into which it ingests the solid particles that constitute its food, and within which it subjects them to a regular process of digestion. Hence these simplest members of the two kingdoms, which can scarcely be distinguished from each other by any *structural* characters, seem to be *physiologically* separable by the mode in which they perform those actions wherein their life most essentially consists.

There are found, both in fresh and salt waters, numerous examples of this Rhizopod type, which do not present any essential advance upon the Amœba and Actinophrys; and a large proportion of these are endowed with a shelly investment which may be either calcareous or siliceous,—the former being the characteristic of the *Foraminifera*, the latter of the *Polycystina*. In some of these testaceous forms, the pseudopodia are put forth only from the mouth of the shell, whilst in other cases this is perforated with minute apertures for their passage; but where there are no such apertures, the sarcode body not unfrequently extends itself over the entire external surface of the shell, and may give off pseudopodia in every direction. Generally speaking, the Foraminifera live attached to sea-weeds, zoophytes, &c.; but their pseudopodia have a very extensive range, and form a sort of animated spider's web, most wonderfully adapted for the prehension of food. The absence of any membranous investment to these threads is clearly indicated by their fusion or coalescence when two or more happen to come into contact; and sometimes a fresh expansion of sarcode takes place at spots remote from the body, so as to form new centres from which a fresh radiation of pseudopodia proceeds.

By far the greater number of Foraminifera are *composite* fabrics, evolved, like zoophytes, by a process of continuous gemmation, each *gemma* or bud remaining in connection with that from which it was put forth; and according to the plan on which this gemmation takes place, will be the configuration of the composite body thereby produced. Where the segments succeed each other in a line, that line is very commonly bent into a spiral; and each new segment being a little larger than the preceding, the spire gradually opens out, so that the shell very closely resembles that of the Nautilus, both in its form and in its chambered structure. There is, however, this essential difference,—that whereas in the nautilus and other chambered shells formed by cephalopod mollusks, the animal lives only in the outermost chamber, all the inner ones having been successively vacated by it, each chamber in the foraminiferous shell continues to be occupied by a segment of the composite body, communicating with the segments within and without by threads of sarcode, which traverse minute passages left in the partitions between the chambers. In the classification of these forms, an extraordinary amount of allowance has to be made for the very wide range of variation that may present itself within the limits of one and the

WEEKLY EVENING MEETING,

Friday, March 26.

Sir Benjamin Collins Brodie, Bart. D.C.L. F.R.S. Vice-President, in the Chair.

Rev. John Barlow, M.A. F.R.S. Vice-Pres. & Sec. R.I.

On Mineral Candles and other Products manufactured at Belmont and Sherwood.

The candles and the other products (liquid hydro-carbons), on which Mr. Barlow discoursed, are manufactured by Price's Candle Company, at Belmont and Sherwood, according to processes patented by Mr. Warren De la Rue. The novelty of these substances consists—1. In the material from which they are obtained. 2. In the method by which they are elaborated. 3. In their chemical constitution.

1. The *raw material* is a semifluid naphtha, drawn up from wells sunk in the neighbourhood of the river Irrawaddy, in the Burmese empire. The geological characteristics of the locality are sandstone and blue clay. In its raw condition the substance is used by the natives as a lamp-fuel, as a preservative of timber against insects, and as a medicine. Being in part volatile, at common temperatures, this naphtha is imported in hermetically-closed metallic tanks, to prevent the loss of any constituent. Reichenbach, Christison, Gregory, Reece,* Young,† Wiesman (of Bonn), and others have obtained from peat, coal, and other organic minerals, solids and liquids bearing some physical resemblance to those procured from the Burmese naphtha; but the first-named products have, in every instance, been formed by the decomposition of the raw material. The process of De la Rue, is, from first to last, a simple separation, without chemical change.

2. *The processes adopted.*—In the commercial processes, as carried out by Mr. George Wilson, at the Sherwood and Belmont Works, the crude naphtha is first distilled with steam at a temperature of 212° Fahr.; about one-fourth is separated by this operation. The distillate consists of a mixture of many volatile hydro-carbons; and it is extremely difficult to separate them from each other on account of their vapours being mutually very diffusable, however different may be their boiling points. In practice,

* See Proceedings of the Royal Institution, Vol. I., p. 4. † Ibid, p. 135.

much light as a candle weighing ¼th lb., made of spermaceti or of stearic acid. Its property of fusing at a very low temperature into a transparent liquid, and not decomposing below 600° Fahr. recommends this substance as the material of a bath for chemical purposes. As to the fluids obtained in the second distillation, already described, they all possess great lubricating properties; and, unlike the common fixed oils, not being decomposable into an acid, they do not corrode the metals, especially the alloys of copper, which are used as bearings of machinery. This aversion to chemical combination, which characterizes all these substances, affords, not only a security against the brass-work of lamps being injured by the hydro-carbon burnt in them, but also renders these hydro-carbons the best detergents of common oil lamps. It is an interesting physical fact, that some of the non-volatile liquid hydro-carbons possess the fluorescent property which Stokes has found to reside in certain vegetable infusions.

3. *Chemical constitution of these hydro-carbons.*—On this subject, there will be found a short memoir by Warren de la Rue, and Hugo Müller, in the Proceedings of the Royal Society, Vol. viii., page 221. The researches referred to in that memoir are nearly completed. The principal constituents of the Burmese naphtha, are—(*a*), (the largest in proportion) a substance identical in composition with either the hydrurets or the radicals of the ethyle series; (*b*) Substances of the benzole series, forming a comparatively small portion. It has, however, been ascertained that some of the hydro-carbons of this aromatic series differ in their chemical and physical properties from the analogous members of the same series obtained from the usual sources. This difference is most strongly marked in the case of cumole and its higher homologues of the benzole series,* (*c*) the colophene series already adverted to.

An important characteristic of the Burmese naphtha is its being almost entirely destitute of the hydro-carbons belonging to the olefiant-gas series.

[J. B.]

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* In illustration of this view may be cited, Church's discovery of a parabenzole in coal tar, boiling at 185° Fahr., and not solidifying at 32°.

organic bodies, selected from the large number above spoken of, as being capable of artificial formation from their elements :—

Name.	Formula.
Oxalic Acid	$(C_2 O_3, H O)_2$
Hydrocyanic Acid	$C_2 N, H$
Light Carburetted Hydrogen . . .	$C_2 H_4$
Urea	$C_2 N_2 H_4 O_2$.
Formic Acid (Acid of Ants) . . .	$C_2 H O_3, H O$.
Chloroform	$C_2 H Cl_3$.
Acetic Acid	$C_4 H_3 O_3, H O$.
Alcohol	$C_4 H_5 O, H O$.
Ether	$(C_4 H_5 O)_2$.
Olefiant Gas	$C_4 H_4$.
Acetic Ether	$C_4 H_5 O, C_4 H_3 O_3$.
Oil of Garlic	$(C_6 H_5 S)_2$.
Oil of Mustard	$C_6 H_5 S, C_2 N S$.
Glycerine	$C_6 H_8 O_6$.
Butyric Acid	$C_8 H_7 O_3, H O$.
Pine Apple flavour (Butyric Ether) .	$C_8 H_7 O_3, C_4 H_5 O$.
Succinic Acid	$C_8 H_4 O_6, 2 H O$.
Valerianic Acid	$C_{10} H_9 O_3, H O$.
Pear flavour (Acetate of Amyl) . .	$C_4 H_3 O_3, C_{10} H_{11} O$.
Apple flavour (Valerianate of Amyl) .	$C_{10} H_9 O_3, C_{10} H_{11} O$.
Lactic Acid	$C_{12} H_{12} O_{12}$.
Grape Sugar ?	$C_{12} H_{12} O_{12}$.
Caproic Acid	$C_{12} H_{11} O_3, H O$.
Benzole	$C_{12} H_6$.
Nitrobenzole	$C_{12} H_5 N O_4$.
Aniline	$N (C_{12} H_5) H_2$.
Phenyl Alcohol (Creosote)	$C_{12} H_5 O, H O$.
Picric Acid	$C_{12} H_2 (N O_4)_3 O, H O$.
Salicylic Acid	$C_{14} H_5 O_5, H O$.
Salicylate of Methyl (Oil of Wintergreen)	$C_{14} H_5 O_5, C_2 H_3 O$.
Naphthaline	$C_{20} H_8$.

The artificial formation of urea, lactic acid, and caproic acid, is interesting in connection with certain functions of the animal economy. Pine-apple oil, pear oil, and apple oil, are instances of the artificial production of the delicate flavours of fruit, whilst oil of wintergreen and nitrobenzole are like examples of the formation of esteemed perfumes. But of all the bodies hitherto thus produced, alcohol, glycerine, and sugar, are undoubtedly the most deeply interesting, owing to the part they take in the nutrition of animals : they prove to us the possibility of producing, without vegetation or any vital intervention, an important part of the food of man. Should the chemist also succeed in forming artificially the nitrogenous constituents of food, without which life cannot be maintained, it would then be possible for a man, placed upon a barren

by the force of the wind, and our carriages by animal power, than to employ steam power for these purposes. We do not find it desirable to wait for the bleaching of our calicoes by the sun's rays; and even the grinding of corn is no longer entirely confided to wind and water power.

In such cases, where contemporaneous natural agencies have been superseded, we have almost invariably drawn upon that grand store of force collected by the plants of bygone ages, and conserved in our coal fields. It is the solar heat of a past epoch that furnishes the power which we now utilise in our steam-engines. One important element in cheap production is *time*, and it is precisely in regard to this element, that we economically supersede, in the above instances, the contemporary resources of nature. Now time is also an important element in the natural production of food; and although it is true, that the amount of labour required for the production of a given weight of food is not considerable, yet it is nevertheless true that this weight requires a whole year for its production. By the vital process of producing food we can only have one harvest in each year. But if we were able to form that food from its elements without vital agency, there would be nothing to prevent us from obtaining a harvest every week; and thus we might, in the production of food, supersede the present vital agencies of nature, as we have already done in other cases, by laying under contribution the accumulated forces of past ages, which would thus enable us to obtain in a small manufactory, and in a few days, effects which can be realized from present natural agencies, only when they are exerted upon vast areas of land, and through considerable periods of time.

[E. F.]

WEEKLY EVENING MEETING,

Friday, June 4.

The Duke of Northumberland, K.G. F.R.S. President, in the Chair.

John Tyndall, Esq. F.R.S.

Professor of Natural Philosophy, Royal Institution.

On the Mer-de-Glace.

A portion of a series of observations made upon the Mer-de-Glace of Chamouni during the months of July and August last year formed the basis of this discourse.

GENERAL MONTHLY MEETING,

Monday, June 7.

THE LORD ASHBURTON, D.C.L. F.R.S. Vice-President, in the Chair.

Professor Thomas Minchin Goodeve, M.A.
James Johnston, Esq.
Mrs. Portlock, and
Miss Anne Swanwick.

were duly *elected* Members of the Royal Institution.

The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM

Hon. East India Company—Bombay Observations for 1856. 4to. 1857.
Airy, G. B. F.R.S. (Astronomer-Royal)—Description of the Galvanic Chronographic Apparatus at the Royal Observatory, Greenwich. 4to. 1858.
Astronomical Society, Royal—Monthly Notices, May, 1858.
Author, The—The Social Evil. 8vo. 1858.
Bradbury, Henry, Esq. M.R.I. (the Author)—Printing: its Dawn, Day, and Destiny. 4to. 1858.
British Architects, Royal Institute of—Proceedings in May 1858. 4to.
Editors—The Medical Circular for May 1857. 8vo.
The Practical Mechanic's Journal for May 1858. 4to.
The Journal of Gas-Lighting for May 1858. 4to.
The Mechanics' Magazine for May 1858. 8vo.
The Athenæum for May 1858. 4to.
The Engineer for May 1858. fol.
The Artizan for May 1858.
Faraday, Professor.—Reale Accademia delle Scienze, Napoli:—Memorie, Vol. I. fasc 2. Vol. II. 1857. Rendiconto. 1856–7. 4to.
Geological Society—Proceedings, May, 1858.
Quarterly Journal, No. 54. 8vo. 1858.
Greenwich, Royal Observatory—Observations in 1856. 4to. 1858.
Linnean Society—Proceedings, No. 8. 8vo. 1858.
Logan, Sir W. E. (the Director)—Geological Survey of Canada. Report for 1853–6. 8vo. and 4to. 1857.
Lunacy Commissioners—Tenth and Eleventh Reports. 8vo. 1856–7.
Mendicity Society—Fortieth Annual Report. 8vo. 1858.
Robin, M. Ed.—Loi Nouvelle régissant les Différentes Propriétés Chimiques, &c. 8vo. Paris, 1853.
Royal Society of Literature—Transactions, Vol. VI. Part 1. 8vo. 1857.
Taylor, Alfred S. M.D. F.R.S. M.R.I. (the Author)—Medical Jurisprudence. 6th Ed. 16to. 1858.
Wilson, Thos. Esq. M.R.I.—Etudes sur les Fécules les plus usitées, par Dr. Saugerres. 8vo. 1858.
Yates, James, Esq. F.R.S. M.R.I. (the Author)—What is the best Unit of Length? 8vo. 1858.

The value of the public recognition of science as a leading branch of education, may be estimated in a very considerable degree by observation of the results of the education which it has obtained incidentally from those, who pursuing it, have educated themselves. Though men may be specially fitted by the nature of their minds for the attainment and advance of literature, science, or the fine arts, all these men, and all others, require first to be educated in that which is known in these respective mental paths; and when they go beyond this preliminary teaching, they require a self-education directed (at least in science) to the highest reasoning power of the mind. Any part of pure science may be selected to show how much this private self-teaching has done, and by that to aid the present movement in favour of the recognition generally of scientific education in an equal degree with that which is literary; but perhaps electricity, as being the portion which has been left most to its own development, and has produced as its results the most enduring marks on the face of the globe, may be referred to. In 1800, Volta discovered the voltaic pile; giving a source and form of electricity before unknown. It was not an accident, but resulted from his mental self-education: it was, at first, a feeble instrument, giving feeble results; but by the united mental exertions of other men, who educated themselves through the force of thought and experiment, it has been raised up to such a degree of power as to give us light, and heat, and magnetic and chemical action, in states more exalted than those supplied by any other means.

In 1819, Oersted discovered the magnetism of the electric current, and its relation to the magnetic needle; and as an immediate consequence, other men, as Arago and Davy, instructing themselves by the partial laws and action of the bodies concerned, magnetized iron by the current. The results were so feeble at first as to be scarcely visible; but, by the exertion of self-taught men since then, they have been exalted so highly as to give us magnets of a force unimaginable in former times.

In 1831, the induction of electrical currents one by another, and the evolution of electricity from magnets was observed,—at first in results so small and feeble, that it required one much instructed in the pursuit, to perceive and lay hold of them; but these feeble results, taken into the minds of men already partially educated and ever proceeding onwards in their self-education, have been so developed, as to supply sources of electricity independent of the voltaic battery or the electric machine, yet having the power of both, combined in a manner and degree which they, neither separate nor together, could ever have given it, and applicable to all the practical electrical purposes of life.

To consider all the departments of electricity fully, would be to lose the argument for its fitness in subserving education, in the vastness of its extent; and it will be better to confine the attention to one application, as the electric telegraph, and even to one small

mind becomes comprehensive. It teaches to deduce principles carefully, to hold them firmly, or to suspend the judgment:—to discover and obey *law*, and by it to be bold in applying to the greatest what we know of the smallest. It teaches us first by tutors and books to learn that which is already known to others, and then by the light and methods which belong to science to learn for ourselves and for others;—so making a fruitful return to man in the future for that which we have obtained from the men of the past. Bacon, in his instruction, tells us that the scientific student ought not to be as the ant who gathers merely, nor as the spider who spins from her own bowels, but rather as the bee who both gathers and produces.

All this is true of the teaching afforded by any part of physical science. Electricity is often called wonderful—beautiful;—but it is so only in common with the other forces of nature. The beauty of electricity, or of any other force, is not that the power is mysterious and unexpected, touching every sense at unawares in turn, but that it is under *law*, and that the taught intellect can even now govern it largely. The human mind is placed above, not beneath it; and it is in such a point of view that the mental education afforded by science is rendered supereminent in dignity, in practical application, and utility; for, by enabling the mind to apply the natural power through law, it conveys the gifts of God to man.

[M. F.]

GENERAL MONTHLY MEETING,

Monday, July 5.

THE LORD ASHBURTON, D.C.L. F.R.S. Vice-President, in the Chair.

James Don, M.D.

was duly *elected* a Member of the Royal Institution.

Robert Tait, Esq.

was *admitted* a Member of the Royal Institution.

The Secretary announced, That the Managers had appointed PROFESSOR RICHARD OWEN, D.C.L. F.R.S. to be Fullerian Professor of Physiology, on June 14th last.

INDEX TO VOL. II.

END OF VOL. II.